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COASTAL PROCESSES STUDY OF THE OCEANSIDE, CALIFORNIA, LITTORAL --ETC(U)
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MISCELLANEOUS PAPER H-78-8

COASTAL PROCESSES STUDY OF THE OCEANSIDE, CALIFORNIA, LITTORAL CELL

by

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August 1978
Final Report

Approved For Public Release; Distribution Unlimited

Prepared for U. S. Army Engineer District, Los Angeles
Los Angeles, Calif. 90053

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Miscellaneous Paper H-78-8	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) COASTAL PROCESSES STUDY OF THE OCEANSIDE, CALIFORNIA, LITTORAL CELL.		5. TYPE OF REPORT & PERIOD COVERED (9) Final report. May-Aug 77, 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Lyndell Z. Hales		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer Waterways Experiment Station Hydraulics Laboratory P. O. Box 631, Vicksburg, Mississippi 39180		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Engineer District, Los Angeles P. O. Box 2711 Los Angeles, California 90053		12. REPORT DATE (11) August 1978 13. NUMBER OF PAGES 363
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

(12) 464 p.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(14) WES-MP-H-78-8

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Beach erosion
Coastal morphology
Littoral drift
Littoral zone
Oceanside, Calif.
Shore protection

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Persistent and devastating erosion of the beaches south of the Oceanside, California, Harbor and Del Mar Boat Basin, with an accompanying accretion of sand in the harbor and entrance channel, has been a continuing critical problem since the construction of the Del Mar Boat Basin and the protective breakwaters. In order to eliminate these problems, certain engineering works of improvement have been proposed, among which are additional breakwater systems, beach fill, and sand by-passing procedures. Congress has accepted ______ (Continued) Cont'

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

78 10 17 051

038 100

20. ABSTRACT (Continued).

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It was determined that approximately 800,000 cu yd gross, 1,200,000 cu yd gross, and 1,900,000 cu yd gross of material are moving at Las Flores, Oceanside, and Encinitas, respectively, on an annual average basis. Also, an estimated 100,000 cu yd net of littoral material is moving southerly past Oceanside, California, on an annual average basis, with the net volume increasing in a southerly direction south of the vicinity of Oceanside.

PREFACE

The investigation reported herein was requested by the U. S. Army Engineer District, Los Angeles, in December 1976, and was subsequently authorized by intra-army order for reimbursable services dated 6 January 1977. The study was conducted during the period May to August 1977.

The study was performed by personnel of the Hydraulics Laboratory, U. S. Army Engineer Waterways Experiment Station (WES), under the general direction of Mr. H. B. Simmons, Chief, Hydraulics Laboratory, and Dr. R. W. Whalin, Chief, Wave Dynamics Division. Data analysis was conducted under the direct supervision of Mr. C. E. Chatham, Jr., Chief, Harbor Wave Action Branch, and Mr. D. D. Davidson, Chief, Waves Research Branch. The report was prepared by Dr. L. Z. Hales, Waves Research Branch.

Commander and Director of WES during the conduct of this study and preparation and publication of this report was COL John L. Cannon, CE. Technical Director was Mr. F. R. Brown.

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CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) AND METRIC (SI) TO U. S. CUSTOMARY UNITS OF MEASUREMENTS

Units of measurement used in this report can be converted as follows:

Multiply	By	To Obtain
U. S. Customary to Metric (SI)		
feet	0.30480000	metres
fathoms	1.82880000	metres
knots (international)	0.51444440	metres per second
miles (U. S. statute)	1.60934400	kilometres
degrees (angular)	0.01745329	radians
cubic yards	0.76511000	cubic metres
Metres (SI) to U. S. Customary		
metres	3.280839	feet
metres	0.546807	fathoms
metres per second	1.943845	knots (int.)
kilometres	0.621371	miles (statute)
radians	57.295788	degrees (ang.)
cubic metres	1.307002	cubic yards

COASTAL PROCESSES STUDY OF THE OCEANSIDE, CALIFORNIA, LITTORAL CELL

PART I: INTRODUCTION

1. Persistent and devastating erosion of the beaches south of the Oceanside, California, Harbor and Del Mar Boat Basin, with an accompanying accretion of sand in the harbor and entrance channel, has been a continuing critical problem since the construction of the Del Mar Boat Basin and the protective breakwaters. In order to eliminate these problems, certain engineering works of improvement have been proposed, among which are additional breakwater systems, beach fill, and sand by-passing procedures.

2. Congress has accepted Federal responsibility for erosion control at Oceanside, based on the opinion that the longshore littoral transport of material in the surf zone has a net southerly direction. Because of conflicting conclusions regarding both the volume and direction of transport, the U. S. Army Corps of Engineers, Los Angeles District, requested that the U. S. Army Engineer Waterways Experiment Station (WES) perform an independent analysis using the latest ocean wave statistical data as input to ascertain quantitatively the rate of longshore transport in this region. It was determined that on the orders of 800,000 cu yd gross, 1,200,000 cu yd gross, and 1,900,000 cu yd gross of material are moving at Las Flores, Oceanside, and Encinitas, respectively, on an annual average basis. Also, on the order of 100,000 cu yd net of littoral material are moving southerly past Oceanside, California, on an annual average basis, with the net volume increasing in a southerly direction south of the vicinity of Oceanside.

PART II: STATEMENT OF THE PROBLEM

3. Oceanside, California, is located close to the center of a littoral cell which extends from Dana Point on the north to La Jolla on the south. There is considerable evidence of sand losses down the La Jolla submarine canyon, as this region has been intensively studied by Scripps Institution of Oceanography, which is located in La Jolla. However, there is little, if any, evidence of littoral drift around Dana Point. These data interpretations enforce the observations that net drift appears to be from north to south, although reversals occur frequently as a result of the varying wave climate. The location of the Oceanside California Littoral Cell is shown in Figure 1, where it can be noted that the entire length of the cell is fronted by relatively uniform underwater contours out to the 300-fathom depth, with these contours approaching very near the shoreline at both Dana Point and La Jolla.

4. The beach sand within this littoral cell moves up- and down-coast during periods of heavy wave action, with the direction of movement depending upon the angle of wave attack. In effect, the surface layer of beach sand moves up-coast or down-coast and on-shore or off-shore depending on the wave characteristics. However, if there is a sand "sink" such as a submarine canyon as there is at La Jolla, the sand moves into the canyon never to return to the cell. Any barrier which interrupts the longshore littoral transport, such as a long groin or breakwater or large entrance channel to a harbor, will effectively act as a "sink" until enough material has accumulated to by-pass the system and continue the sand transfer down the coastline.

5. The harbor complex at Oceanside, California, is, in effect, a sand "sink" in the middle of the littoral cell which traps sand moving in either direction, not just in the direction

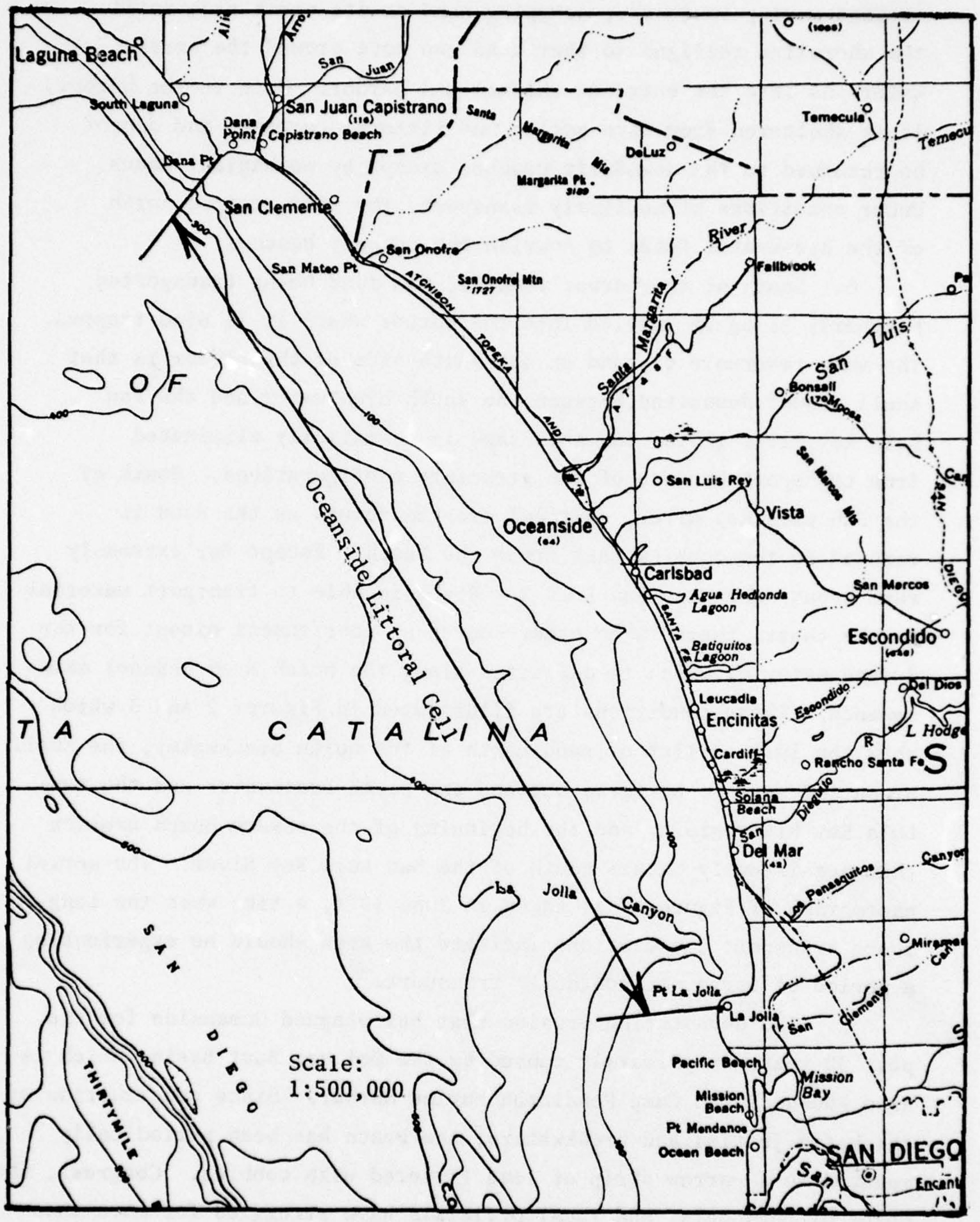

Figure 1. Oceanside, California, Littoral Cell

of net transport. The main northern breakwater acts as a barrier to sand moving southerly, trapping sand on its north side until the shoreline realigns so that sand can move around the breakwater and into the entrance channel and harbor. Once in the harbor, it is sheltered from wave action and littoral currents and cannot be returned to the downdrift beaches except by mechanical means. Under conditions of northerly transport, the sand trapped north of the breakwater tends to nourish the upcoast beaches.

6. South of the harbor complex, the sand being transported northerly is again carried into the harbor where it is also trapped. The only reservoir of sand on the south side of the harbor is that small amount deposited between the south breakwater and the San Luis Rey River groin, and this sand is essentially eliminated from transport because of the structure configurations. South of the San Luis Rey River, critical erosion occurs as the sand is removed to the cobbles that armor the beach. Except for extremely rare events when the San Luis Rey River is able to transport material to the coast, there is no other source of nourishment except for the dredge material which is deposited along the beach from channel maintenance. These conditions are illustrated in Figures 2 and 3 which show the large fillet of sand north of the north breakwater, the small amount of sand to be found between the south breakwater and the San Luis Rey River groin, and the beginning of the severe beach erosion that persistently occurs south of the San Luis Rey River. The aerial photograph of Figure 3 was taken in June 1974, a time when the longshore transport computations indicate the area should be experiencing a period of large net southerly transport.

7. The devastating erosion that has plagued Oceanside for the past 30 years is primarily caused by the Del Mar Boat Basin, which is also known as the Camp Pendleton Marine Harbor. Since construction of the basin jetties and breakwaters, the beach has been periodically reduced to a narrow strip of land littered with cobbles. Congress, the Corps of Engineers, and local officials have struggled for more than 20 years to save and restore the beach: Congress by authorizing studies and appropriating the necessary monetary funds for remedial

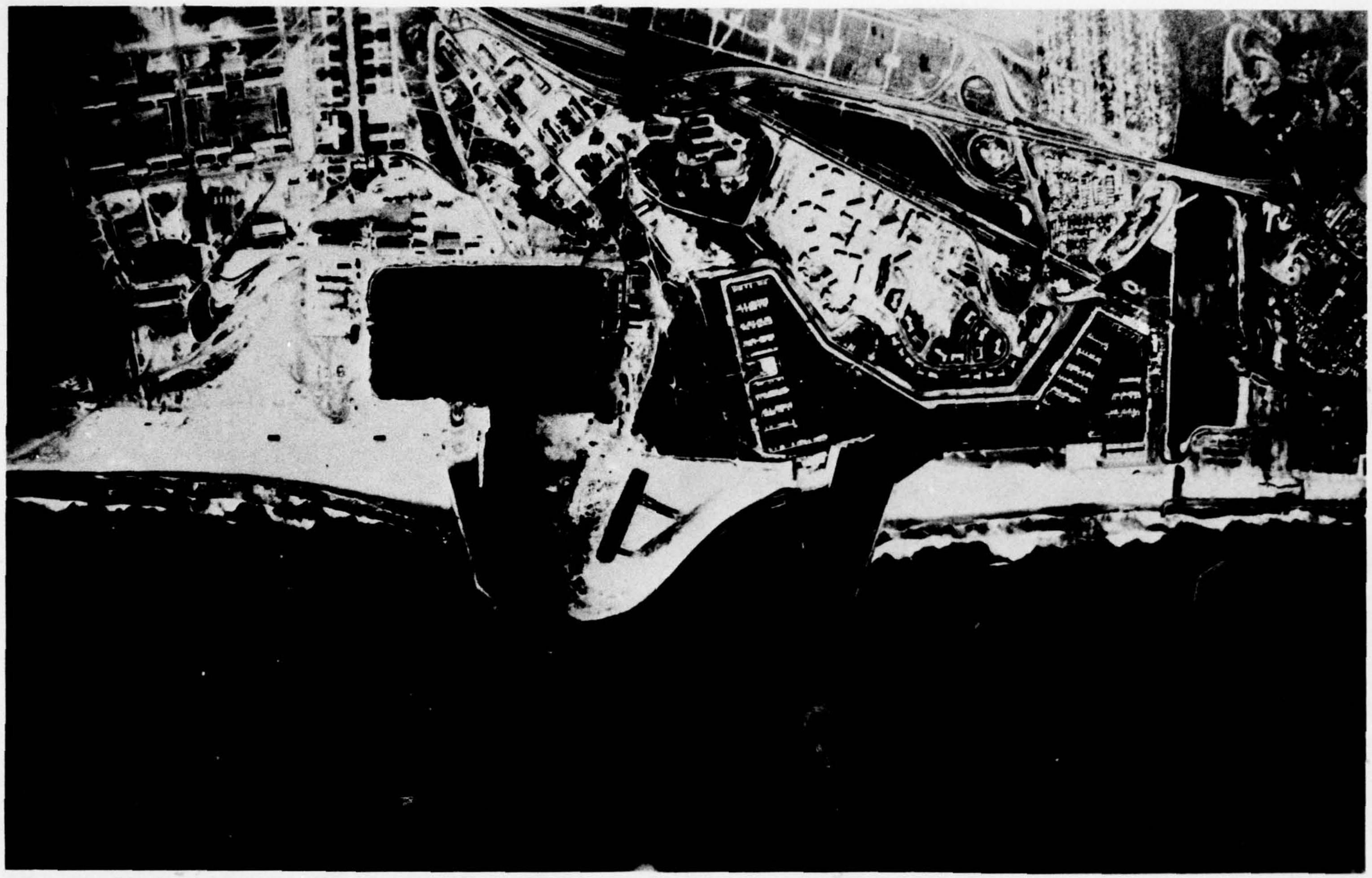

Figure 2. Oceanside, California, harbor complex, showing sand accumulation near the jetties

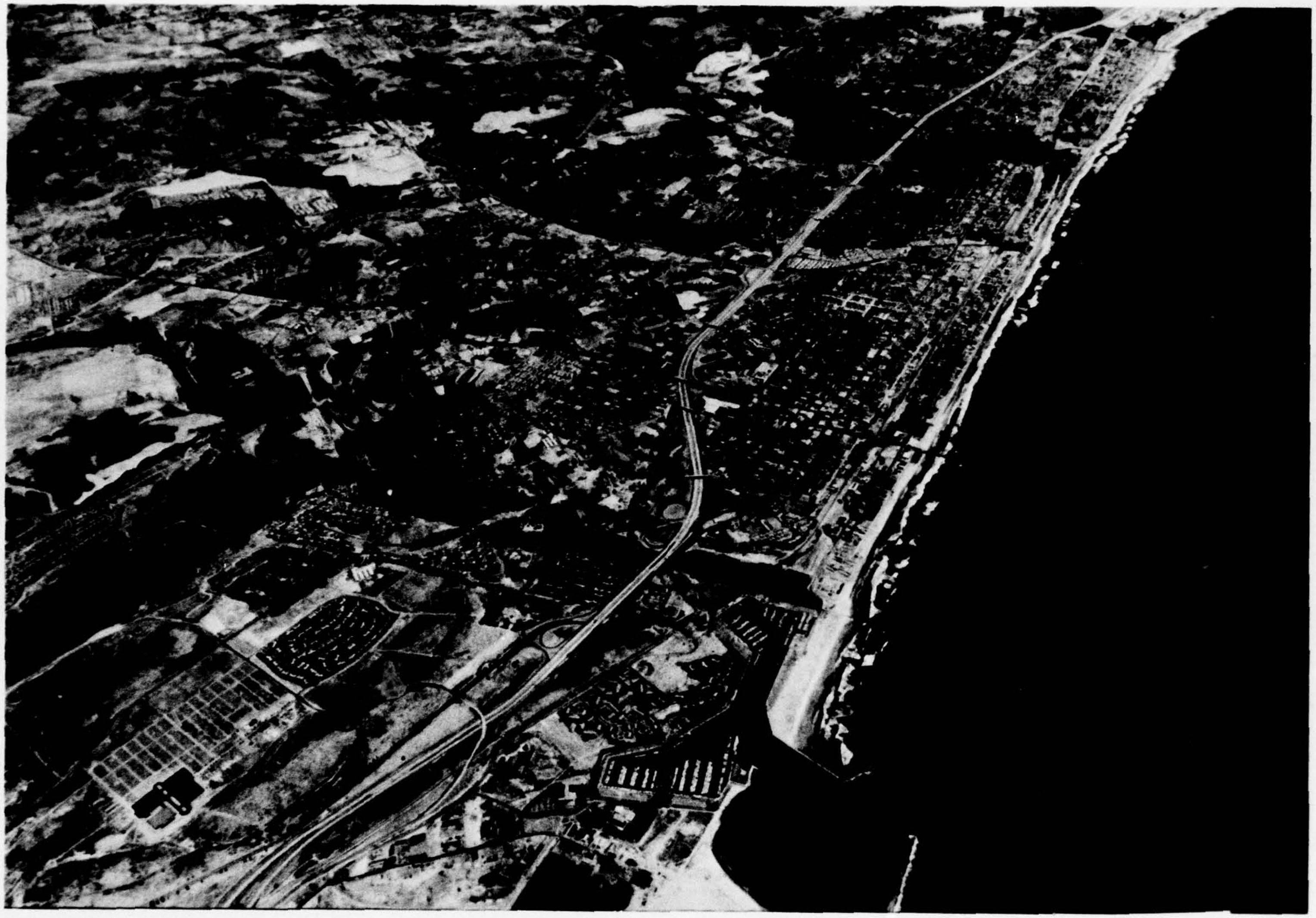

Figure 3. Oceanside, California, showing severe beach erosion south of the harbor complex

work; the Corps by making the studies and doing the work; and local officials by providing whatever emergency assistance they could make available to local residents facing the destruction of or damage to their homes and businesses.

8. Full Federal responsibility for restoration of the beach at Oceanside was assumed in 1961, when Congress passed Public Law 87-9 authorizing the Oceanside beach erosion control project in accordance with the recommendations of the Chief of Engineers in House Document 456, 86th Congress, 2d session. In his report, the Chief of Engineers indicated that (a) the jetties at Camp Pendleton Harbor, which were constructed as a wartime measure without provisions for preventing damage to the adjoining shores, are primarily responsible for the erosion problem at Oceanside; and (b) the restoration and stabilization of the Oceanside shoreline should be a Federal responsibility since Camp Pendleton Harbor is used entirely for military purposes and produces no local benefits. The current study indicates that the considered improvements are within the purview of Section 111 of the 1968 River and Harbor Act, which authorizes the Corps of Engineers to:

> ".....investigate, study, and construct projects for the prevention or mitigation of shore damages attributable to Federal navigation works. The costs of installing, operating, and maintaining such projects shall be borne entirely by the United States................................."

9. To date, almost $7 million has been spent at Oceanside on work related to beach erosion primarily caused by the Del Mar Boat Basin: $1.4 million by the Corps and $0.6 million by local interests on shore protection and sand deposition work; $2.7 million by the Corps for dredging of Oceanside Harbor and depositing dredged material on Oceanside beach; and $2 million by the Navy for dredging Del Mar Boat Basin and depositing this dredged material on the beach.

PART III: PHYSIOGRAPHIC SETTING

10. Northward from La Jolla, the shoreline gradually bends from north-northwest to northwest and sandy beaches are virtually continuous to Dana Point, except where cut away temporarily by winter storms and for the semi-permanent erosional problems at Oceanside. The towns are built mostly along elevated wave-cut terraces ranging from 50 to 150 feet above sea level. Near Oceanside and Carlsbad the sea cliff has a distinct terrace at 50 to 75 feet.

11. Along most of the Oceanside California Littoral Cell from Del Mar to San Onofre, the sea cliffs range in height from about 30 to 120 feet. Thin Pleistocene marine sands on terrace surfaces commonly overlie Eocene and Miocene sandstones and shales. Most shales have slumped blocks where the sea cliff is nearly vertical. The sandy beaches are relatively wide during summer, but waves break directly against the cliffs mostly during the storm season when the beaches have been largely cut away.

12. The cliffs along this region of coastline are interrupted by eight partly filled estuaries at the mouths of the larger wet-weather streams. Almost all of the estuaries of the Southern California coast are found here, and are considerably filled as a result of the large source of sediment derived during floods from the nearby mountains. According to Shepard and Wanless,[1] a predominance of southward beach drift along the coast causes barrier spits to form across the estuaries from the north. Most of the estuaries are now connected with the ocean only through temporary channels opened artificially after each serious flood.

13. Approximately 70 per cent of the sand beaches in this region are at the base of sea cliffs that must be classed as of erosional origin over a long time span but depositional over shorter time spans when a wide sand beach is present. Sand reaches

these beaches chiefly from streams and to a lesser extent from erosion of the sea cliffs, based on the conclusions of Emery.[2] Most of the sediment comes during large infrequent floods. The contribution of streams during years of ordinary rainfall is not well known. Existing information on stream contribution is based on rate of erosion of watersheds which, in turn, is inferred from the rate of deposition in reservoirs and flood debris basins in up-stream areas. There is little reason to assume that all the coarse sediment which is trapped would have crossed the lowlands between the traps and the ocean.

14. A second method of estimating stream contribution has been that of measuring the rate of accretion behind breakwaters near the stream mouths, but little sediment finer than sand is trapped, and it is virtually impossible to separate the contribution of littoral drift from that of nearby streams. The sediment supplied to the beach by streams and cliff erosion ranges from fine- to coarse-grained. The fine-grained sediment is carried away in suspension by longshore currents and finally diffuses seaward; and the medium- to coarse-grained sand slowly moves along the coastline by saltation. Fully 75 per cent of Southern California beach sand is quartz; another 10 to 15 per cent is feldspar, while the remaining 10 to 15 per cent consists of heavy minerals and, particularly, pitchblende, according to the work of Stambler.[3]

15. Under the considerations of all the uncertainties involved, it is virtually impossible to establish a sediment budget or a mass balance of sediment transport. Since it is possible to compute the longshore transport capacity of the wave climate, it is apparent that if a sufficient source of necessary sediment is not available to satisfy this potential wave capacity, then erosion of the beaches and coastline will result until the sediment load is obtained. In those situations where the beach is armored to such an extent to preclude erosion, then the problem

is transferred down-coast.

16. The east highland portion of the Pacific drainage area in Southern California is composed largely of plutonic intrusive rocks of the southern California batholity, mainly tonalite, granodiorite, and gabbroic rocks. The western or coastal area consists of both marine and non-marine sedimentary deposits of conglomerates, sandstones, siltstones, and shales of the Cretaceous, Tertiary and Quaternary Periods.

17. In late Cretaceous or early Tertiary time, the Oceanside California Littoral Cell was part of a peneplain, a low-lying body of land so reduced by erosion that comparatively little topographic relief remained. A period of uplift followed, accompanied by faulting and folding, forming high mountains along the eastern border and partially breaking up the peneplain. At that time, streams began to carve the present drainage system. The coastal plain, extending from 6 to 14 miles eastward from the shoreline, has been built up of erosion debris and marine sediments. Its present relief, a series of wave-cut terraces, is apparently due to several cycles of submergence and elevation, inaugurated in early Quaternary time and continuing until Recent time.

18. The presence of lagoons and low marshy deltas at the mouths of streams in the northern part of the Oceanside California Littoral Cell is evidence of rather recent subsidence. The existence of boulder and cobble beds as much as 5 miles from the present shoreline indicates that much of the land exposed during the period of land emergence has since resubmerged, although coarse material could also be part of normal sedimentary formations.

19. Recent deposits of fossiliferous sand and loam occur as a veneer on the older rocks in a narrow belt along the shore from San Onofre to Mexico. The terraces along the shore in the Oceanside area are surmounted by ridges of semi-indurated sand containing Pleistocene fossils to elevations as great as 100 feet.

20. The configuration of the shoreline of Southern California is irregular due to differences in geological structure and rock hardness. North of La Jolla, the Tertiary Mesa, composed of rocks of almost equal hardness, has been evenly truncated by wave erosion, resulting in a long series of sea cliffs at the foot of which is a narrow beach. Along this part of the coast, the marine cycle of shoreline development has reached a mature stage. At La Jolla, the shoreline projects out about a mile due to the resistant nature of the hard Cretaceous sandstones which outcrop there at sea level.

21. From Dana Point to La Jolla, almost the entire 45 mile length of this shoreline is bordered by beaches, although small rocky points are found in a few places. In this distance, the trend of the coastline changes gradually from south 70° east at Dana Point to nearly due south at La Jolla. The beaches of this section of shoreline are backed by steep bluffs which reach heights of 100 ft or greater in places. Major drainage features are the Santa Margarita, San Luis Rey, and San Dieguito Rivers.

22. The Dana Point to Santa Margarita River segment of the cell, Figure 1, contains generally very narrow beaches backed by steep, high bluffs and is traversed by numerous short intermittent streams with steep gradients. About 2 miles downcoast from San Onofre Creek, the beach becomes very narrow and is backed by the San Onofre Bluffs which rise to an elevation of 120 ft and continue southward for about 4.5 miles to the mouth of the Horno Canyon. Downcoast of Horno Canyon the bluffs become somewhat lower in height, having a top elevation of 80 ft from Horno Canyon to Las Pulgas Canyon, a distance of 2.5 miles. Las Flores Creek, a small intermittent stream, transects the shoreline at this point. From the mouth of the Las Flores Creek to the mouth of the Santa Margarita River, a distance of about 5 miles, the beach gradually widens and the heights of the bluffs decrease to an elevation of about 40 ft just north of the mouth of the Santa Margarita River.

23. The Santa Margarita River to Batiquito Lagoon section is about 12 miles in length and in this distance the alignment of the coast changes from south 35° east near the river to south 15° east at Batiquitos Lagoon. This stretch of coastline includes Camp Pendleton Harbor, the cities of Oceanside and Carlsbad, Carlsbad Beach and La Costa Beach State Parks. From the Santa Margarita River to Camp Pendleton Harbor entrance, about 1.5 miles, and from the harbor entrance southward for a distance of 1 mile to the mouth of the San Luis Rey River adjacent to the city of Oceanside, the coastline is made up of broad, sandy beaches and barrier dunes that separate the overflow areas at the mouths of the 2 rivers from the ocean. From the San Luis Rey River to Buena Vista Lagoon, a distance of 3 miles, the beach is very narrow and backed by bluffs from 20 to 40 ft high. This area is traversed by one small intermittent stream, Loma Alta Creek, and is entirely within the city limits of Oceanside. The beach between Buena Vista Lagoon and Agua Hedionda Lagoon, 2 miles in length, remains very narrow and subject to severe erosion as is that region south of the Camp Pendleton Harbor at Oceanside.

24. The Batiquitos Lagoon to La Jolla portion of the Oceanside California Littoral Cell, about 17 miles in length, consists of narrow beaches backed by steep bluffs which are interrupted by the mouths of San Elijo Lagoon and San Dieguito and Soledad Valleys, each of which is about 1 mile wide. A few rocky points, which contain pocket beaches, lie within this stretch of shoreline. Populated areas include the communities of Leucadia, Encinitas, Cardiff, Solana Beach, Del Mar and La Jolla. Ponto Beach, Moonlight Beach, San Elijo Beach, Cardiff Beach, and Torrey Pines Beach State Parks lie within this section.

PART IV: CHRONOLOGY OF THE PROBLEM

25. The first evidence of construction into the Oceanside beaches was a wharf about 1,000 ft long located at Wisconsin Avenue which was completed in 1888 and destroyed in 1890 by rough surf. Local interests rebuilt and continued to alter and improve the pier until 1920, but without apparent detrimental effect on the beach processes. In 1922 the Henshaw Reservoir was constructed on the San Luis Rey River, and this structure provided a reduction in the sediment-carrying capacity of the river, thereby diminishing the natural supply of beach material to the Oceanside beaches. By 1925 the usable beach area appeared to be quite narrow, and the width of the beach could be correlated satisfactorily with the stream run-off rates from the San Luis Rey River.

26. During the 1930's additional improvements were made on the beach and in the surf zone, such as a concrete curtain wall and walk-ways with definite groin effects. However, any change in the width of the beach could always be accounted for by correlation with the discharges of the local streams. Photographs taken in 1939 are probably the source of the often-used caption "wide, sandy beaches of Oceanside." A substantial storm of 1938 undoubtedly added a large amount of material to most of the Southern California beaches.

27. In 1942 the U. S. Marine Corps' Del Mar Boat Basin was constructed as a wartime measure with no consideration being given to the effect of the facility on the surrounding environment. The dredged material was spread around the perimeter of the boat basin to raise the grade for building areas. This material apparently contained some of the cobbles (re-dredged later in 1962-63) that show up today on the beaches downcoast of the harbor. The original harbor construction consisted of 2 converging jetties extending seaward to about the -20 ft depth; the upcoast jetty length was about 2,100 ft long, and the downcoast jetty approximately 1,300 ft in length.

28. By 1944-45, the entrance channel had shoaled from a constructed depth of 20 ft to only 14 ft and had decreased in width from 190 ft to 50 ft. Littoral material apparently from an upcoast source had accreted on the north side of the north jetty. The entrance channel was dredged with approximately 219,000 cu yds of material being removed and placed as land reclamation fill. Within 8 months of the dredging an equivalent amount of material had again been deposited in the harbor.

29. During construction of the harbor in 1942 and 1943, erosion of the beach in the vicinity of Oceanside was noticeable. Shortly after completion of the harbor, the littoral drift from upcoast apparently passed sand around the upcoast jetty and shoaled across the entrance channel to the harbor. When the entrance channel was shoaled across, erosion of the downcoast beaches was no longer apparent. After maintenance dredging was undertaken in 1945, erosion again occurred. However, the entrance channel again shoaled and the erosion was once again halted.

30. From these observations it became apparent that if the entrance to Del Mar Boat Basin was maintained to project depths and widths, it would become necessary to by-pass sand past the entrance periodically, both to maintain the harbor without constant maintenance dredging and to prevent erosion damages to the downcoast beaches.

31. Since 1948 the Oceanside area has shown a history of shoreline problems downcoast of the harbor. The City of Oceanside transmitted to the Corps of Engineers in 1949 a comprehensive report of studies by its consulting engineer which concluded that the Oceanside beach was being depleted of material mainly because of the influence on the shoreline by the jetties at Camp Pendleton Harbor. During this year, Vail Dam near the head-waters of the Santa Margarita River was built. The Santa Margarita River is one of the two main sources of natural beach replenishment material for the Oceanside area, and this construction undoubtedly had some

effect on the supply of sand to the local beaches. However, any supply of littoral material by the Santa Margarita River must still pass the entrance channel to the boat basin before it can be useful to the downcoast beaches, and this it cannot do unless the entrance channel shoals excessively.

32. During the 1950's, local interests continued to construct seawalls and stone revetments in order to protect their investments. Groins extending seaward to about mean sea level in the area of Wisconsin Avenue were built, but from a cursory study it would seem that the groins had no accretion effect, probably due to length and location.

33. In 1953, the Corps of Engineers determined that the Oceanside beach depletion was due primarily to the Camp Pendleton jetties. A beach erosion study was made to determine what would be the most economical means of re-establishing and maintaining the former recreational beach. At that time the beach had receded to such an extent as to threaten destruction of the public roadways, utilities, and commercial and residential property. In this study it was determined that the public and private interests could best be served by artificially providing a protective beach, about 200 ft wide and 10,000 ft long, by the deposition of 900,000 cu yds of material along this area. In 1955 the Corps of Engineers again reported that the primary cause of erosion at Oceanside beach was the impoundment of littoral drift material at the Camp Pendleton Harbor jetties.

34. Before construction of the protective beach could be initiated, the U. S. Navy extended the upcoast jetty about 900 ft in the existing direction, and another 1,400 ft downcoast was added. In conjunction with this construction, the Navy dredged approximately 800,000 cu yd of material which were deposited on the downcoast beaches to alleviate some severe erosion problems which were threatening the streets and sewer lines. This fill material showed no inclination to remain in place and started

to move out of the area almost immediately and the beach continued to erode. A large portion of this material probably returned upcoast into the entrance channel and against the north jetty.

35. During the early 1960's, the Oceanside Small Craft Harbor was constructed adjacent to the Del Mar Boat Basin with the addition of a new south jetty and an accompanying groin on the north side of the San Luis Rey River. Almost 4 million cu yds of material was dredged from the small craft harbor and the Del Mar Boat Basin, and the material was placed on the downcoast beaches. During the dredging of the small craft harbor numerous cobbles were encountered. This enormous beach fill of 1963, while restoring the Oceanside beaches to the pre-harbor configuration, showed no inclination to remain in a stable condition. Recession of the entire stretch of beach started almost immediately.

36. Beach erosion continued through 1965, and shoaling in the harbor and entrance channel accelerated. Emergency maintenance dredging was required and dredge material was deposited on the beach. In this year the first mention was made of the appearance of the cobbles on the beach. From this date on, the cobbles dominate the beach front, seeming to be more noticeable in an area from about Witherby Street upcoast to the pier. While unsightly and undoubtedly causing a loss of revenue to the City, they seem to have a retarding effect on the rate of beach erosion.

37. Since that time periodic maintenance dredging of the entrance channel on an almost annual basis has been required. This material has been deposited on the downdrift beaches with a magnitude approaching 360,000 cu yd annually.

38. The problems at Oceanside, California, seem to have been caused by a combination of 3 factors: (1) The original construction of the Del Mar Boat Basin jetties in 1942-43; (2) A prolonged period of drought causing a withholding of the natural amounts of littoral material; and (3) To some extent, the floodwater retarding structures built along the San Luis Rey and

Santa Margarita Rivers. These two rivers once provided major sources of beach sediments for the littoral cell at Oceanside. Neither has produced much nourishment to the beaches in recent years due in part to flood control systems in their upper watersheds, Figure 4, but perhaps due even more to a lack of extreme rainfall and large amounts of flood flow. From a navigation standpoint, this has been fortunate for, if both rivers produced large deltas, maintaining adequate channel depths would indeed be more difficult and costly.

39. Selected views of the Oceanside, California region are shown in Figures 5 through 8. Here it is readily apparent that the destructive forces causing the erosion of the beaches are still at work, although the extent of shoaling in the entrance channel is not as apparent at the present time as in the earlier years due to the fact that the channel is much larger and the severe filling is not permitted to occur before the channel is re-dredged for navigation purposes. From a historical standpoint, the chronology of the dredging events at Oceanside Harbor are shown in Table 1.

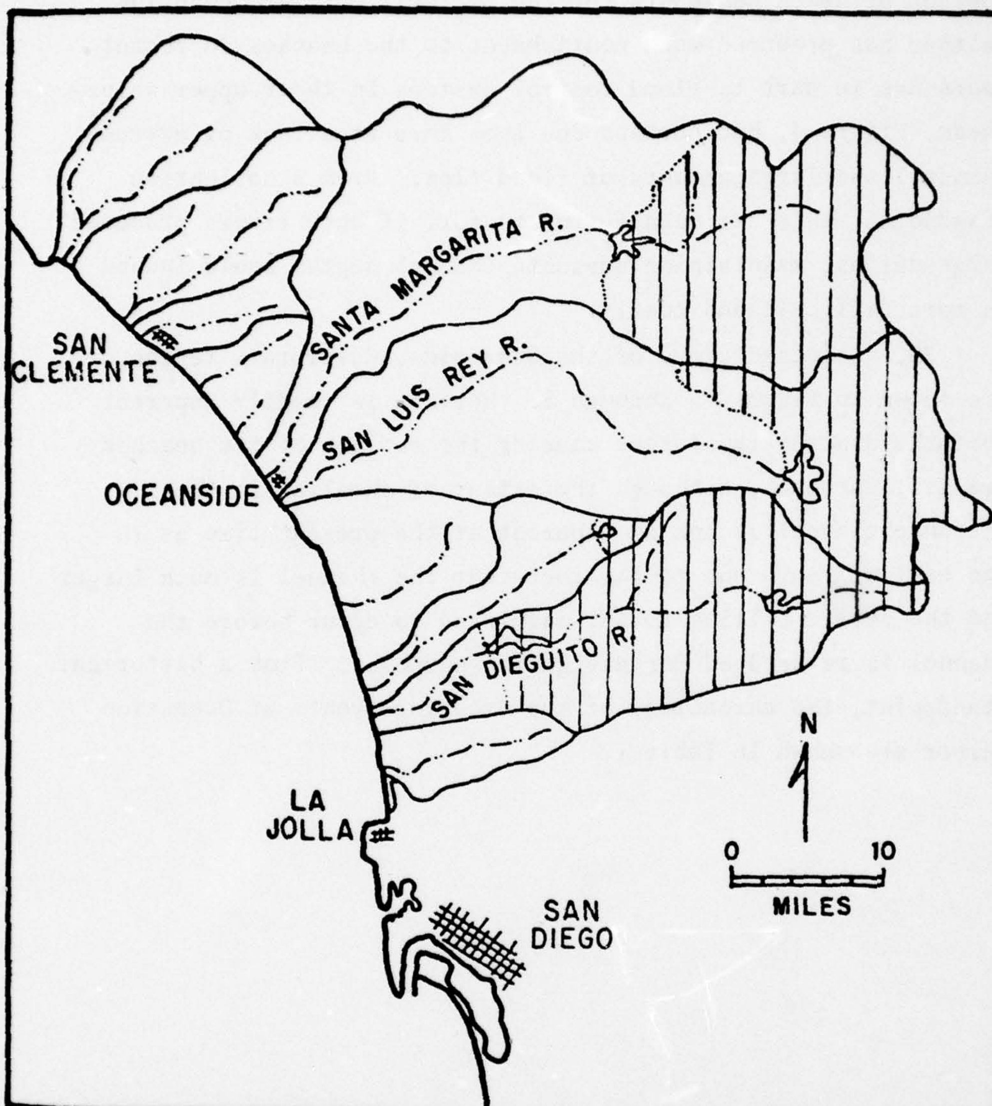

Figure 4. Drainage basins contributing to the Oceanside California Littoral Cell, showing the area regulated by flood control dams and sediment retention structures. (after State of California, 1969)

Figure 5. Camp Pendleton Harbor entrance channel, April 1949, showing severe filling of the navigation section

Figure 6. Cobbled beach at Oceanside, California, exposed by severe beach erosion, located between Camp Pendleton Harbor and Municipal pier

Figure 7. Extreme beach erosion at Oceanside, California, located immediately south of the armored cobbled section of beach

Figure 8. Section of Oceanside, California, beach protected by stone placement to alleviate continuing erosion

PART V: ALTERNATIVE IMPROVEMENT CONSIDERATIONS

40. At a public meeting held at Oceanside, California, in 1968, a plan was presented for future harbor expansion which would increase the present capacity by 774 slips, add 29 acres of lease land, and 7 acres of parking. The proposed expansion would be confined by the south jetty, the south groin, and an extension between the jetty and groin which would be about 1,500 ft offshore and approximately parallel to the shoreline. The entrance for the proposed harbor would be cut through the existing berm and riprap at the base of the south jetty.

41. In 1969 a meeting was held with Navy and Marine Corps personnel and representatives of the Corps of Engineers where the subject matter was the expansion and revamping of the Del Mar Boat Basin. These modifications are necessary to accommodate the larger L.S.T.'s presently being built for amphibious warfare. Subsequent meetings have been held and discussions continue as to the possibilities for modifying the harbor complex. At the present time the Corps of Engineers is proceeding with considerations assuming an expansion of the Oceanside Small Craft Harbor and a combination of alternatives for stabilizing and maintaining an acceptable recreation beach downcoast.

42. Various alternative protective measures are being considered for the beach at Oceanside. Eight of these alternatives are enumerated, along with a summary of their beneficial and adverse effects.

<u>1. No Action:</u> There would be no disruption of existing marine and shore environment. However, the erosion will continue as before, causing property damage and loss of recreational beach.

<u>2. Rock Revetments:</u> May be less expensive than other measures such as seawalls, breakwaters, or groins. However, they

would ruin the beach as a recreational facility because of extreme danger of injury. They would be very expensive if they were properly designed to be effective against beach loss.

3. Concrete Seawalls: Could be made aesthetically pleasing, and they will protect property from erosion-induced damage. However, seawalls will not protect and maintain the beach because erosion will take place seaward of the seawall. They are also relatively expensive because of the heavy foundation required to prevent undercutting from scour.

4. Groin Systems: Would be effective in retaining sand from littoral transport. However, groins are not effective against sand loss from offshore-onshore movement, and they could be hazardous to small children. Dangerous rip currents also occur quite frequently between groins, and they are not usually aesthetically pleasing to local sponsors or to the public.

5. Sandfills: Aesthetically most desirable to the public. This would replenish the littoral stream each time the sandfill is replenished, and no major *environmental* disruption of marine organisms seaward of the surf zone will occur. However, this method would require periodic replenishment, which is very expensive in the long run. It also would cause a temporary environmental disruption of the marine organisms in the surf zone during placement.

6. Offshore Breakwaters: If submerged, would be aesthetically preferable to rock revetments, seawalls, and groin systems. Would also protect the beach from sand loss due to onshore-offshore transport as well as longshore transport along the shore. They might somewhat reduce shoaling in Oceanside Harbor from upcoast littoral transport, and could possibly improve the aquatic habitat as an artifical reef. However, unless properly marked by lights and buoys, they could be dangerous to boaters, skin divers, and swimmers. They could also cause a temporary disruption of marine life seaward from the surf zone during construction.

7. Permanent By-passing Systems: Might eliminate the need for additional shore-protection structures, and may reduce the maintenance cost for the two harbors. However, they could cause continual, though reduced, disruption of small marine organisms due to continual sediment deposition in the surf zone.

8. Remove Del Mar Boat Basin and Oceanside Harbor: Would substantially reduce erosion at Oceanside, and would eliminate maintenance cost for the two harbors. However, this removal would also eliminate a Navy base vital to national defense, and would affect the economy of Oceanside. It would also eliminate a harbor of refuge for small craft, since the distance between Dana Point Harbor and Mission Bay Harbor is more than 50 miles. The Corps of Engineers and the State of California recommend a maximum distance of 35 miles between harbors of refuge for small craft.

43. The first three alternative measures for consideration are inappropriate to solve the erosion problem of a recreational beach, and the removal of Del Mar Boat Basin and Oceanside Harbor is not practical. Hence, only alternatives 4, 5, 6, and 7 should be given serious consideration, and these four measures are being evaluated individually and collectively in an attempt to formulate beach erosion and control plans. These four plans are now being considered in great detail in order to arrive at an optimum solution.

Plan No. 1: Groin Systems

44. Alternative Plan No. 1 consists of five rubble-mound groins about 500 ft long, placed at intervals of 1,000 ft. The groins would have a crest elevation of 10 ft above mean lower low water. The seaward toe of each groin would be 8 ft below mean lower low water. The groins would be high enough to preclude overtopping from most waves, thereby preventing the transport of sand over the groin system. The side slopes of the groins would be

1 vertical on 1.5 horizontal and the head or seaward ends would have slopes of 1 vertical on 2 horizontal. Each groin would be sealed with a concrete curtain to prevent sand passing through the structure. The shoreward end would be so keyed as to prevent flanking by high waves or tides. The seaward ends of the groins would be within the surf zone and, consequently, would not constitute a hazard to navigation or require the placement of buoys or other navigation aides. A stabilizing sandfill of 800,000 cu yd would be placed between the groins and at each end and would allow some littoral drift to naturally by-pass the protected areas while they are stabilizing and thus minimize erosion of the adjacent beaches.

Plan No. 2: Sandfills

45. Alternative Plan No. 2 provides for no rigid structures of any kind on the beach because the plan depends upon the effectiveness of the energy-dissipating qualities of the gently sloping beach. The fill, consisting of 1.3 million cu yd of sandy material (median grain size of 0.5 mm) would be so placed as to approximate the fill (3.8 million cu yd) placed in 1962-63. This plan would be effective only by continual replenishment of the beach to replace the eroded sand.

Plan No. 3: Offshore Breakwaters

46. Alternative Plan No. 3 would consist of an offshore, partly submerged, stepped breakwater 1,000 ft seaward and parallel to Pacific Street. The breakwater would be 4,500 ft long with a maximum crest width of 10 ft at 0.0 mean lower low water elevation. The seaward side and ends would be on a slope of 1 vertical on 2 horizontal. The landward side would have a slope of 1 vertical on 1.5 horizontal. The breakwater would be approximately on the -10 ft contour.

47. This breakwater would encourage the formation and retention of a characteristic tombolo, which is the bar or spit that naturally develops and grows seaward toward a breakwater, rock, or other island-like structure. This would result in a substantial and permanent protective sand beach. An original sandfill of 500,000 cu yd would be made to encourage the rapid establishment of a stable beach and help reduce erosion of the adjacent beaches early in the project life.

48. Because the structure would be located where small craft might be navigating, it would be necessary to mark the breakwater with buoys or other suitable devices as safety features. These buoys and any white-water associated with the breakwater reef would serve to locate the reef-like fish habitat for fishing and scuba diving activities.

Plan No. 4: Permanent By-passing Systems

49. Alternative Plan No. 4 provides for the establishment of a permanent sand by-passing system to keep the harbor entrance channel free from shoaling material and to provide nourishment for the downcoast beaches. Since the problems of the beach and entrance channel are two-fold and inter-related, the best approach to a remedial action for Oceanside's beach and harbor is to find a solution which imitates the natural sand transport process. This can be achieved by continuously by-passing sand past the entrance channel at the natural rate of supply. Thus, the entrance channel will not shoal and the downcoast beach will receive required sand input to reduce further erosion. A continuous by-passing system would essentially re-establish the natural longshore transport that existed before construction of the harbor entrance. However, the problem still probably exists that with the diminished supply of sediment from the local streams, there may not be enough material

in the natural transport system to eliminate completely the erosion of the beach. But the fact remains, a continuous by-passing system will keep the entrance channel clear of shoal material and provide circulation of littoral material in the Oceanside California Littoral Cell to be accomplished in stages rather than in one operation. It is important that the timing of the by-passing be in harmony with wave forces and directions; otherwise, the situation could be aggravated.

50. All of the alternative improvement plans considered require knowledge of the volume of littoral material that is being transported past the Oceanside beaches, or being trapped in the harbor entrance channel. For an evaluation of an effective sand by-passing system, it is necessary to know the quantity and direction of transport on a monthly basis to be able to design a system of sufficient capacity. In order to perform longshore transport computations knowledge of the best available average wave climate is required.

PART VI: WAVE CLIMATE ESTIMATE

51. Wave height, period, direction of travel, frequency of occurrence, and energy of wave groups are characteristics requiring consideration in longshore transport computation studies. These characteristics are directly influenced by such physical factors as wave exposure, island sheltering, refraction and shoaling.

Wave Exposure

52. The degree to which a site is open to the directional spectrum of wave energy from distant and local storms is called wave exposure. The amount of wave exposure along the Oceanside California Littoral Cell is dependent on the configuration of the mainland and the existence of the offshore islands. Complete wave exposure is reduced by the sheltering effects of the California coastline and the offshore islands of San Clemente, Santa Catalina, San Nicholas, Santa Cruz, and Santa Rosa. In addition, the Tanner Banks and the Cortes Bank also reduce the exposure of wave energy spectrums having wave periods greater than 11 seconds.

53. Different locations along the Oceanside California Littoral Cell are exposed to a different wave climate due to the fact that the physical orientation of the coastline and islands permit wave exposure windows to vary as one proceeds from Dana Point southward to La Jolla. Hence, it is imperative that proper consideration be given to the particular point of interest regarding the degree of wave exposure.

Island Sheltering Effects

54. If the Oceanside California Littoral Cell was not sheltered by the offshore islands, waves would come in over a wide range of

directions even if the direction of the wind in the generating area was relatively constant. According to Arthur,[5] variability of wave direction makes a path of at least 45° on each side of the wind. A directional beam pattern of wave intensity of the form $(1 + \cos 2\theta)$ has been shown to approximate this spreading function. In effect, the intensity is proportional to the square of the wave height, and this is consistent with observational data. The result of sheltering, then, is to prevent certain parts of the wave fan from reaching the protected area.

55. In investigating island sheltering, the first consideration is to determine which directions of approach are open to waves of various periods and which are blocked. This cannot be accomplished by simply inspecting the sea level contours of the islands, for shoal water can act as a barrier just as effectively as an island shore. The blocking action depends on both water depth and wave period, with long-period waves requiring deeper water for passage than short-period waves; and as a result, any given opening between two islands will present a narrower portal to a long-period wave than it will to a short-period one. With the aid of precise bottom-contour charts, all such avenues of approach were listed for three different specific sites along the Oceanside California Littoral Cell, and the required integrations were performed by digital computer utilizing a program developed by U. S. Army Corps of Engineers, Los Angeles District. The three sites selected for study in order to treat the littoral transport characteristics of the entire cell were Oceanside, a point approximately 10 miles north of Oceanside at Las Flores, and an area near Encinitas approximately 10 miles south of Oceanside.

56. The island sheltering theory yields not only height-reduction ratios but indicates modification in direction as well. Periods are assumed to remain unchanged. The direction modifications are necessary because, in some cases, sheltering will block out part or all of the primary central portion of the direction sector of a train of approaching waves. When this happens, the wave energy

reaching the hindcast point will obviously come from around the two ends of the barrier, and the resulting modified wave train will come from a direction within the original sector but modified toward that end of the barrier around which the larger part of the remaining wave energy came. The island sheltering coefficients, or the percent remaining of the original deep-water wave heights, and the direction-of-approach alterations were applied to the deep water wave climate being utilized in the analysis. The resulting sheltered deep water wave climate was then refracted shoreward to the site of interest. The sheltered deep water depth in all three cases was 600 ft where the refraction analysis was commenced.

Refraction and Shoaling Effects

57. The speed of propagation of a surface gravity wave depends on the depth of water in which the wave propagates. As the wave celerity decreases with depth, the wave-length must decrease proportionally for the period to remain constant. Variation in wave velocity occurs along the crest of a wave moving at an angle to underwater contours because that part of the wave in deeper water is moving faster than the part in shallower water. This variation causes the wave crest to bend toward alignment with the contours. This bending effect, called refraction, depends on the relation of water depth to wave-length. It is analogous to other types of waves, such as light or sound.

58. As waves propagate from deep water into shallower water, changes other than refraction take place. The assumption generally made is that there is no loss of wave energy and negligible reflection. The power being transmitted by the wave train in water of any depth is equal to the power being transmitted by the wave system in deep water. The wave period remains constant in water of any depth, whereas the

wave-length, velocity, and height vary.

59. The transformation of irregular ocean waves is a complex process which is not fully understood. The usual method of treating the problem which is quite successful is to represent the actual system by a series of sinusoidal waves of different heights, periods, and phases. Such a system now has a two-dimensional energy spectrum. The wave statistics being analyzed in the present study are treated in such a manner.

60. The effects of refraction and shoaling are important for several reasons. These phenomena determine the wave height in any particular water depth for a given set of incident deep-water wave conditions; i.e., wave height, period, and direction of propagation in deep water. Refraction and shoaling, therefore, have significant influence on the wave height and distribution of wave energy along the coast. The change in wave direction of different parts of the wave results in convergence or divergence of wave energy, and materially affects the forces exerted by waves on structures and on longshore transport of littoral material in the surf zone.

Data Sources

61. Ocean wave statistics compiled from a 29-year data base (1946-1974) are available from the California Department of Navigation and Ocean Development (DNOD) for six deep water stations along the California coast. The U. S. Navy Fleet Numerical Weather Central program has produced synoptic singular wave analyses for the northern hemisphere since 1946. These data have been archived on magnetic tape, and have been utilized to provide deep water wave statistics for coastal engineering applications similar to those prepared by National Marine Consultants[6] (NMC, 1960) and Marine Advisers[7] (MA, 1961), which have been the basis of design for harbor and shore protection projects in California. These new statistics

by Meteorology International, Inc.[8] (1977) not only increase the data base (from 3 to 29 years), but also refine the wave direction from 22 1/2° to 10° and provide additional information on persistence of wave of various heights.

62. The wave model used by Fleet Numerical Weather Central (FNWC) is based upon converting barometric observations from ship and shore stations into a pressure field. A wind field is mathematically derived from this pressure field and imposed on a grid covering the northern hemisphere. At each grid point wave heights, periods, and directions are mathematically generated for each 24-hour period. If the wind wave is 5 ft or more in height, a swell train is initiated along a great circle track in the same direction as the wind wave and carried from grid point to grid point until the swell wave decays to less than 3 ft or reaches land. At each grid point, both the wind wave (sea) and a swell wave are recorded.

63. The Fleet Numerical Weather Central grid system does not follow the California coastline, and it was deemed desirable to have deep water statistics available near the coast at convenient intervals for a number of coastal engineering applications. Six locations were chosen, Figure 9. Stations 5 and 6 along the Southern California coast are sufficiently offshore in deep water so that island effects not considered by the numerical model are avoided. Consideration was given to decreasing the distance between stations; however, it was determined that for most applications, a simple linear interpolation between stations is sufficient. Accordingly, a hypothetical Station 5 1/2 was established half-way between Stations 5 and 6 and is located in deep water oceanward of the sheltering islands.

64. Inman[9] has presented a general wave exposure diagram for Oceanside which shows the extent to which wave energy entering the Southern California area is affected by the offshore islands, Figure 10. This general wave exposure situation must be refined considerably before application to the three sites of interest

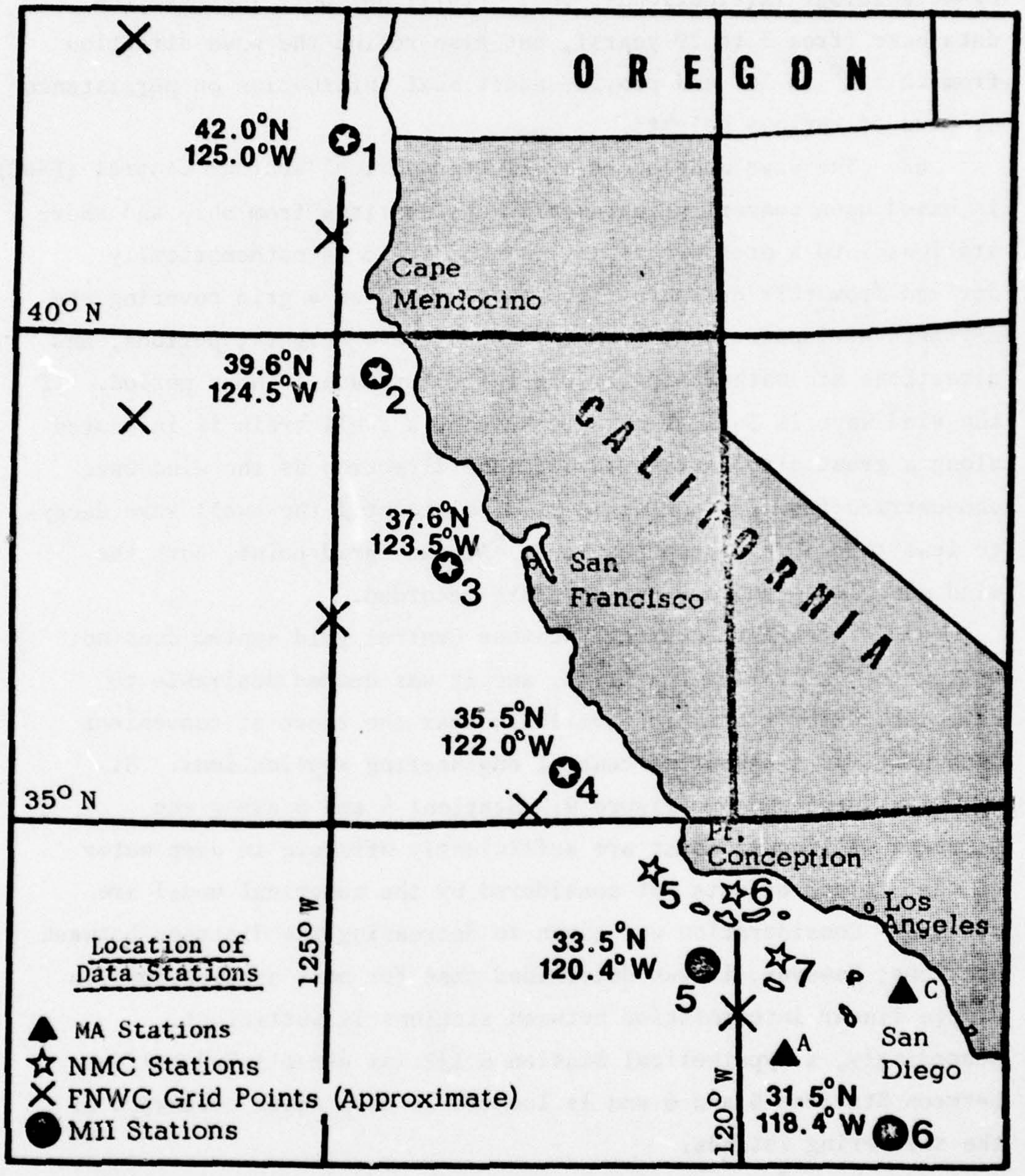

Figure 9. Location of deep water wave statistical stations off the coast of California by National Marine Consultants, Marine Advisers, and Meteorology International, Inc. (after Meteorology International, Inc.)

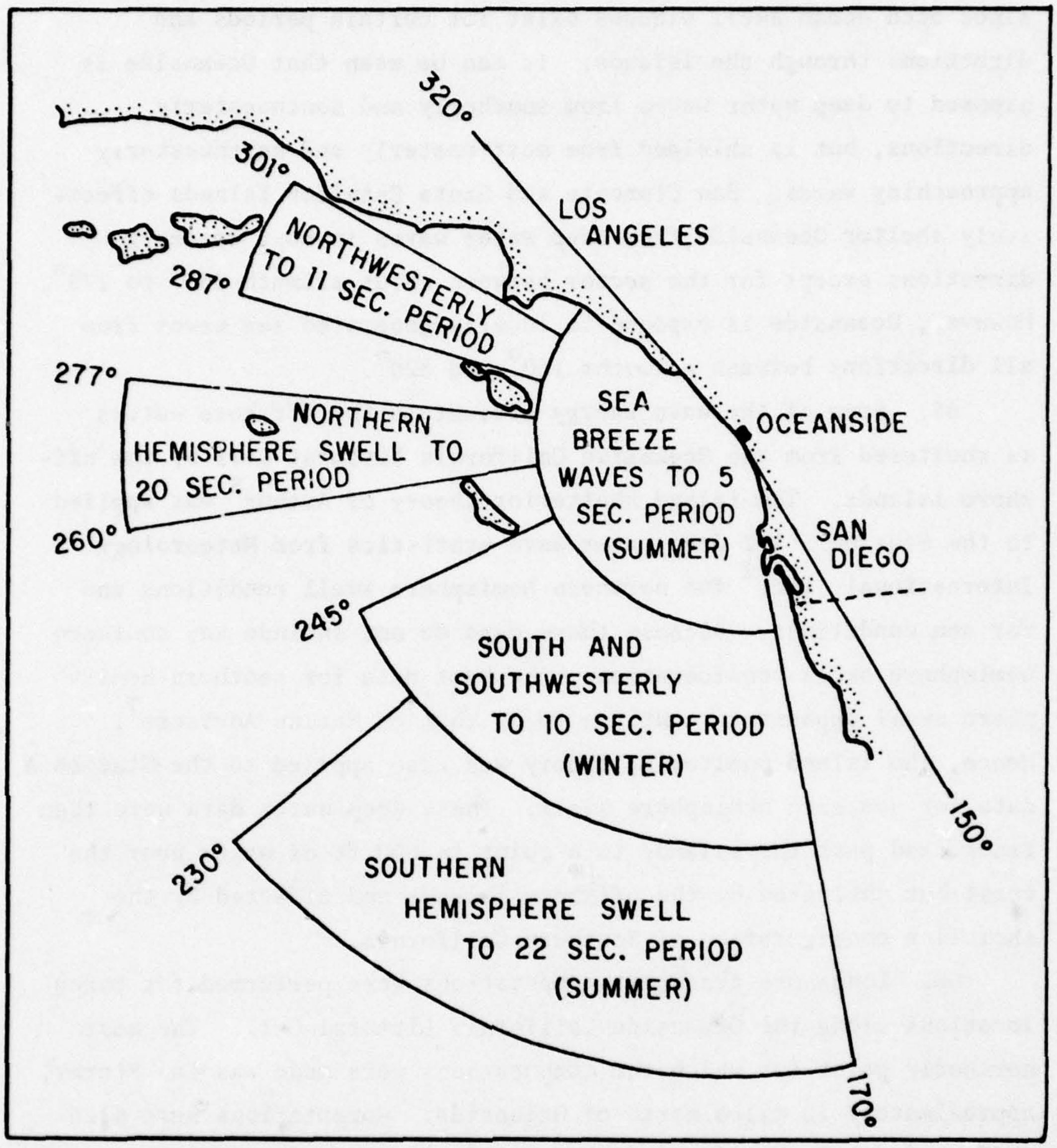

Figure 10. Generalized wave exposure chart for Oceanside, California (after Inman)

since open ocean swell windows exist for certain periods and directions through the islands. It can be seen that Oceanside is exposed to deep water waves from southerly and southwesterly directions, but is shielded from most westerly and northwesterly approaching waves. San Clemente and Santa Catalina Islands effectively shelter Oceanside from deep water waves in most westerly directions except for the sector between about azimuth 260° to 275°. However, Oceanside is exposed to locally generated sea waves from all directions between azimuths 160° and 320°.

65. Some of the wave energy present in the offshore waters is sheltered from the Oceanside California Littoral Cell by the offshore islands. The island sheltering theory of Arthur[5] was applied to the Station 5 1/2 deep water wave statistics from Meteorology International, Inc.[8] for northern hemisphere swell conditions and for sea conditions. Because these data do not include any southern hemisphere swell considerations, the best data for southern hemisphere swell appears to continue to be that of Marine Advisers[7]. Hence, the island sheltering theory was also applied to the Station A data for southern hemisphere swell. These deep water data were then transfered past the islands to a point in 600 ft of water near the coast but sheltered by the offshore islands and affected by the shoreline configuration of Southern California.

66. Longshore transport computations were performed for three locations along the Oceanside California Littoral Cell. The most northerly point for which the computations were made was Las Flores, approximately 10 miles north of Oceanside. Computations were also performed for Oceanside, and at a point approximately 10 miles south of Oceanside, at Encinitas. For each of these three points, wave refraction analyses were conducted by using the latest hydrographic survey data overlain by a 400 ft square depth grid. This provided detail and permitted the computations to proceed to the breaker zone for all wave conditions. The refraction analyses thus provided a series of calibration curves for selected wave heights and periods

for each direction-of-approach band. From these calibration curves of the effect of deep water wave height, period, and direction of approach on breaker height and breaker angle, the appropriate value for each element appearing in the wave statistics matrix could be determined. Ultimately, the amount of longshore transport attributed to this element was evaluated.

PART VII: LONGSHORE TRANSPORT COMPUTATIONS

67. Analyses of existing aerial photography and erosion-accretion rates at various points along the Oceanside California Littoral Cell by different investigators for many years have historically led to the conclusion that the net annual longshore transport for the cell is in a southerly direction. For example, Inman[9] estimated the longshore transport rates at Oceanside Harbor to be 215,000 cu yd of material annually. This study was made by using the only wave data available at that time, that data by Marine Advisers[7]. So strong has been the opinion that the net transport direction is to the south that Congress has accepted Federal responsibility for the erosion at Oceanside based on this conclusion. Inman's theoretical cell is shown in Figure 11.

68. When the necessity arose for a monthly breakdown of the rates of gross and net longshore transport past the Oceanside Harbor complex for the purpose of preliminary design of sand transfer systems and engineering works of improvement for controlling beach erosion, the U. S. Army Engineer District, Los Angeles, performed independent computations using the same Marine Advisers[7] Station C data.

69. According to the Shore Protection Manual[10], it is accepted practice to use calculated wave conditions to compute a longshore component of "wave energy flux" which is related through an empirical relationship to longshore transport rates. This conceptual model is based on the assumption that longshore transport rates, Q, depend on the longshore component of energy flux in the surf zone. The longshore energy flux in the surf zone is approximated by assuming conservation of energy flux in shoaling waters, using small-amplitude theory, and then evaluating the energy flux relationship at the breaker position. Ultimately, it can be shown that:

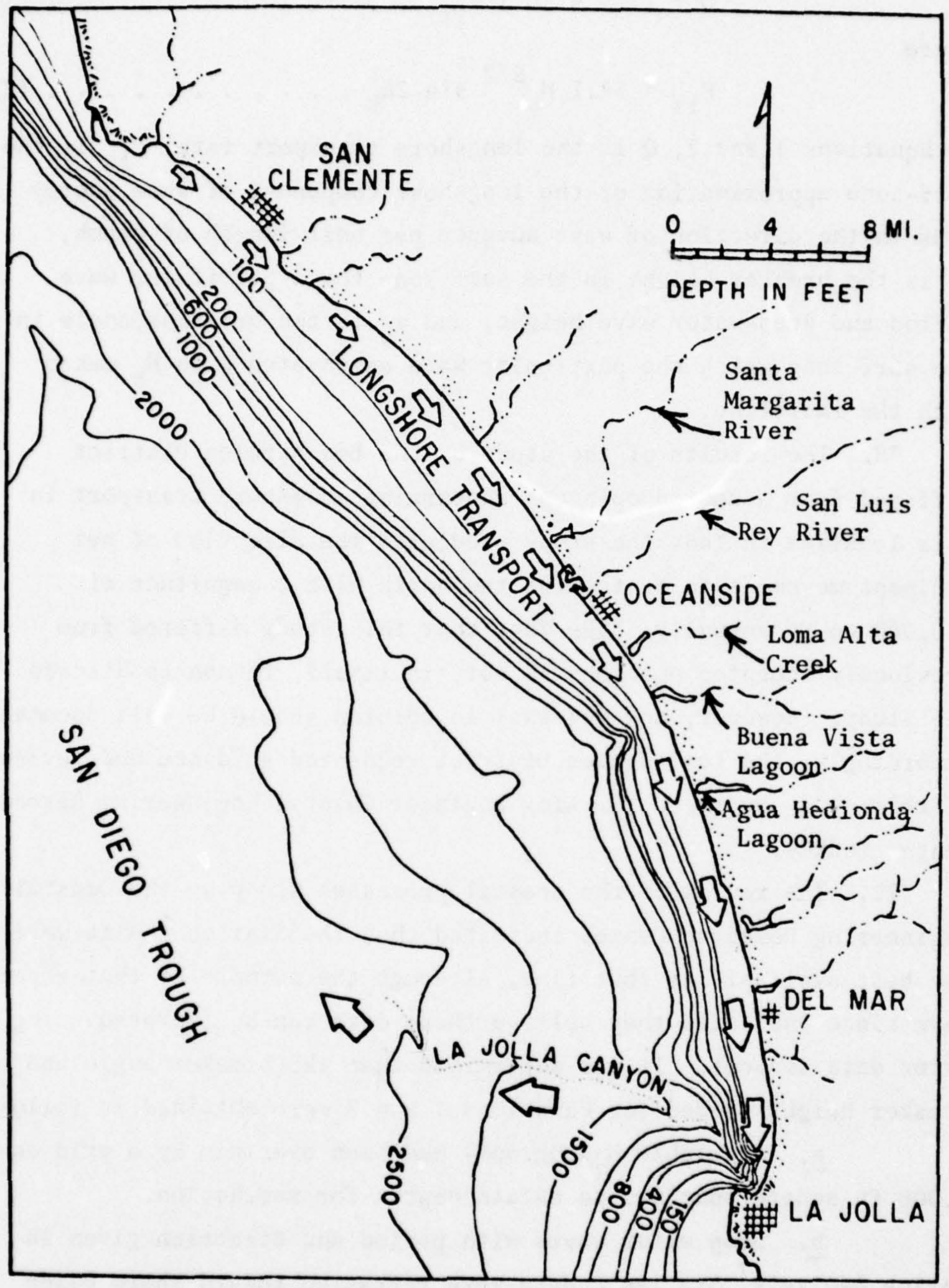

Figure 11. Theoretical Oceanside California Littoral Cell, showing probable direction of net longshore transport (after Inman)

$$Q = (7.5 \times 10^3)\, P_{ls} \quad \ldots\ldots\ldots\ldots \quad (1)$$

where

$$P_{ls} = 32.1\, H_b^{5/2} \sin 2a_b \quad \ldots\ldots\ldots\ldots \quad (2)$$

In Equations 1 and 2, Q is the longshore transport rate, P_{ls} is the surf-zone approximation of the longshore component of wave energy flux in the direction of wave advance per unit length of beach, H_b is the breaker height in the surf zone for a particular wave period and deep-water wave height, and a_b is the breaking angle in the surf zone which the particular wave associated with H_b makes with the shoreline.

70. The results of the study by the Los Angeles District differed from accepted opinions concerning longshore transport in this locality in that the study predicted the direction of net sediment movement to be towards the north with a magnitude of 280,000 cu yd annually. The fact that this study differed from previously accepted opinions is not, in itself, reason to discard the study. However, any reversal in opinion should be well documented. Accordingly, the Los Angeles District requested guidance and review of this study by the U. S. Army Engineer Coastal Engineering Research Center (CERC).

71. The review of the coastal processes study by the Coastal Engineering Research Center indicated that the Station C data were the best available at that time, although the authors of that report have since indicated they believe these data can be improved using later data sources. It was determined that the breaker angle and breaker height needed for Equations 1 and 2 were obtained as follows:

<u>a</u>. Available hydrography had been overlain by a grid on 2,000 ft square spacings to obtain depths for refraction.

<u>b</u>. Deep water waves with period and direction given in Marine Advisers[7] Station C data were refracted toward shore using accepted numerical techniques.

<u>c</u>. The computer program assumed refraction to end at a 6-ft depth, and it computed the breaker angle and height at this point.

d. The breaker angle and breaker heights so calculated were used as input to the program which calculated P_{1s} by Equation 2.

72. Based on review of the Los Angeles District study, the following conclusions were made by the Coastal Engineering Research Center:

a. The basic equation used to compute the longshore transport is Equation 1, and is correct.

b. The breaker angle and breaker height selected for use in Equations 1 and 2 are not correct. The selection of a single depth (6 ft) as the depth to which the offshore waves are refracted has the effect of exaggerating the transport due to southern swell because it gives a higher than actual breaker angle to those low waves. In addition, it reduces the transport due to the higher waves of the northern swell and sea, because it results in a lower breaker angle than would actually occur for these large waves.

73. The recommendations regarding this coastal study were:

a. Because Oceanside has a long enough shoreline and smooth enough contours, use an equivalent equation for deep-water data and eliminate the need to refract the waves into the surf zone to obtain breaker heights and breaker angles. This equivalent deep-water equation is:

$$P_{1s} = 18.3\, H_0^{5/2} \, (\cos a_0)^{1/4} \sin 2a_0 \quad . \; . \; . \; . \quad (3)$$

where the zeros indicate deep water condition.

b. Alternatively, refract the deep-water wave data of Station C into the surf zone until breaking occurs for each element in the wave height-wave period matrix, and determine the amount of longshore transport attributed to these individual increments.

74. Because of personnel limitations at this time, the U. S. Army Corps of Engineers, Los Angeles District, requested the U. S. Army Engineer Waterways Experiment Station to assist by performing the recommendations of the U. S. Army Engineer Coastal Engineering

Research Center regarding longshore sediment transport through the Oceanside California Littoral Cell.

75. The initial effort of the independent study by the Waterways Experiment Station was the application of Equation 3 to the deep-water statistical wave data of Station C. These computations indicated a northern net annual transport of approximately 150,000 cu yd. While this net value is considerable less than the 280,000 cu yd determined previously, the northerly direction still provided consternation which had to be resolved.

76. The second major effort of this evaluation was the refraction of the deep-water wave data of Station C into the breaker zone for the determination of breaker angles and heights. When these results were combined with Equations 1 and 2, there resulted a net longshore annual transport of 250,000 cu yd in a northerly direction. This value was not statistically significantly different from the 280,000 cu yd previously determined by the Los Angeles District, and the northerly direction still could not be accounted for. At this time attention was directed to the acquisition of a later deep-water data source, since the data of Station C was becoming suspect, inasmuch as only three years (1956-58) of hindcast data had been produced from northern and southern hemisphere weather maps for the compilation of these data.

77. The deep-water wave statistical data compiled by Meteorology International, Inc.[8] for the California Department of Navigation and Ocean Development were then applied to the breaker heights and breaker angles through the use of Equations 1 and 2, and the results are in general agreement with other researchers in the area regarding both direction and volume of net annual longshore transport. The calibration curves showing the effect of period, sheltered deep-water wave height, and angle of approach on breaker angle and breaker height are presented in Appendix I and Appendix II for Las Flores, Appendix III and Appendix IV for Oceanside, and Appendix V and Appendix VI for Encinitas.

78. The unsheltered deep-water wave statistical data is presented in Appendix VII. These tables include the southern hemisphere swell data from Marine Advisers[7] Station A, and the northern hemisphere swell and sea data from the hypothetical Station 5 1/2 interpollated from Stations 5 and 6 of the data by Meteorology International, Inc.[8]

79. Since it was necessary to apply island sheltering theory to the deep-water statistical data, each of the three points of interest (Las Flores, Oceanside, and Encinitas) had to be considered individually. Each of these locations had different ocean swell exposure windows and, thus, the island sheltering effects were different for each. The results of the island sheltering theory are given in Appendix VIII for Las Flores, Appendix IX for Oceanside, and Appendix X for Encinitas. These three appendixes now constitute the sheltered deep water wave statistics to which must be applied the breaker angle and breaker height information for longshore computations, according to Equations 1 and 2.

80. The annual longshore transport for each element of the sheltered deep-water wave matrix is presented in Appendix XI for Las Flores, Appendix XII for Oceanside, and Appendix XIII for Encinitas. Each element of these appendixes contain 4 numbers, which are the following:

- Number 1. The per cent of time that this wave existed.
- Number 2. The breaker height of this wave.
- Number 3. The breaker angle of this wave.
- Number 4. The amount of longshore transport attributed to this wave on an annual basis.

These annual computations were then decomposed to a monthly basis.

PART VIII: CONCLUSIONS

81. Summaries of the potential longshore transport capabilities of the wave climate existing at Las Flores, Oceanside, and Encinitas, California, are presented in Tables 2, 3, and 4, respectively. These tables are arranged to display the influence of sea, southern swell, and northern swell on the overall net and gross transport on a monthly basis. Since the same deep-water wave statistics were applied to all three locations, the differences in the transport rates and quantities are directly attributable to the differences in open ocean wave exposure windows and localized topography near the vicinity of each site.

82. The computations at all three locations indicate a net southerly transport direction which is in agreement at least qualitatively with most investigators of this particular phenomenon. Also, the gross rates are the same order of magnitude as have been previously reported. While the net transport rates appear somewhat less than other studies have indicated, this disparity may be due in part to the utilization of a better wave data source in this study. It is significant to recall that the filling of the entrance channel at Oceanside Harbor is determined by the gross transport rates and not by the net volumes. Thus, a situation of zero net transport could possibly provide for complete filling of the entrance channel.

83. The gross and net annual longshore transport computations are shown in Figures 12 and 13, respectively, and from these displays it is apparent that the wave climate and topography combine to provide for a significant increase in the volume of material moved with distance from the northern to the southern portion of the Oceanside California Littoral Cell. It is interesting to note that the net annual longshore transport produced by sea and southern swell increases or decreases almost linearly with distance away from Oceanside, whereas the northern swell conditions permit a greater amount of southern transport at Las Flores that at either of the other two

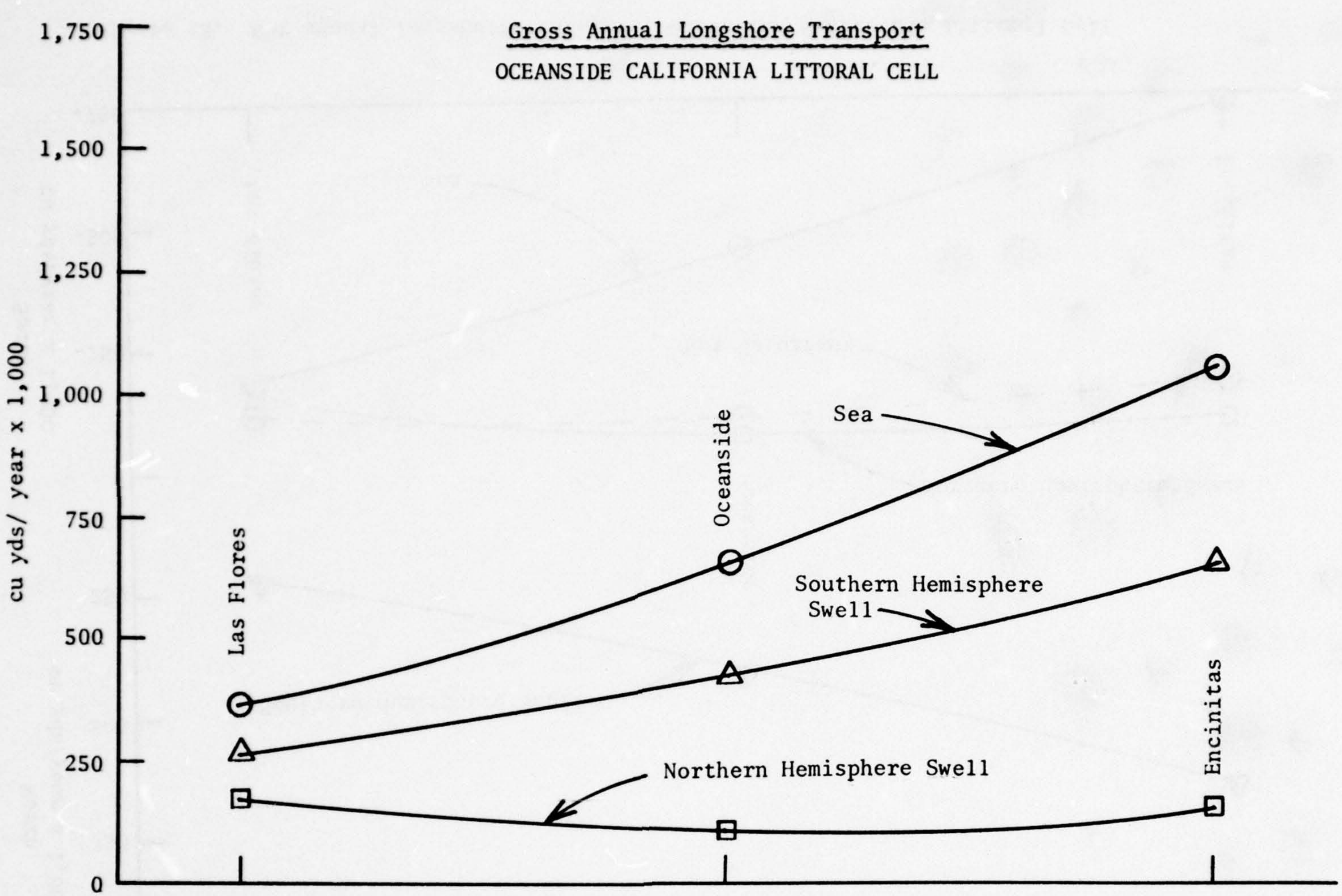

Figure 12. Gross annual longshore transport, Oceanside California Littoral Cell

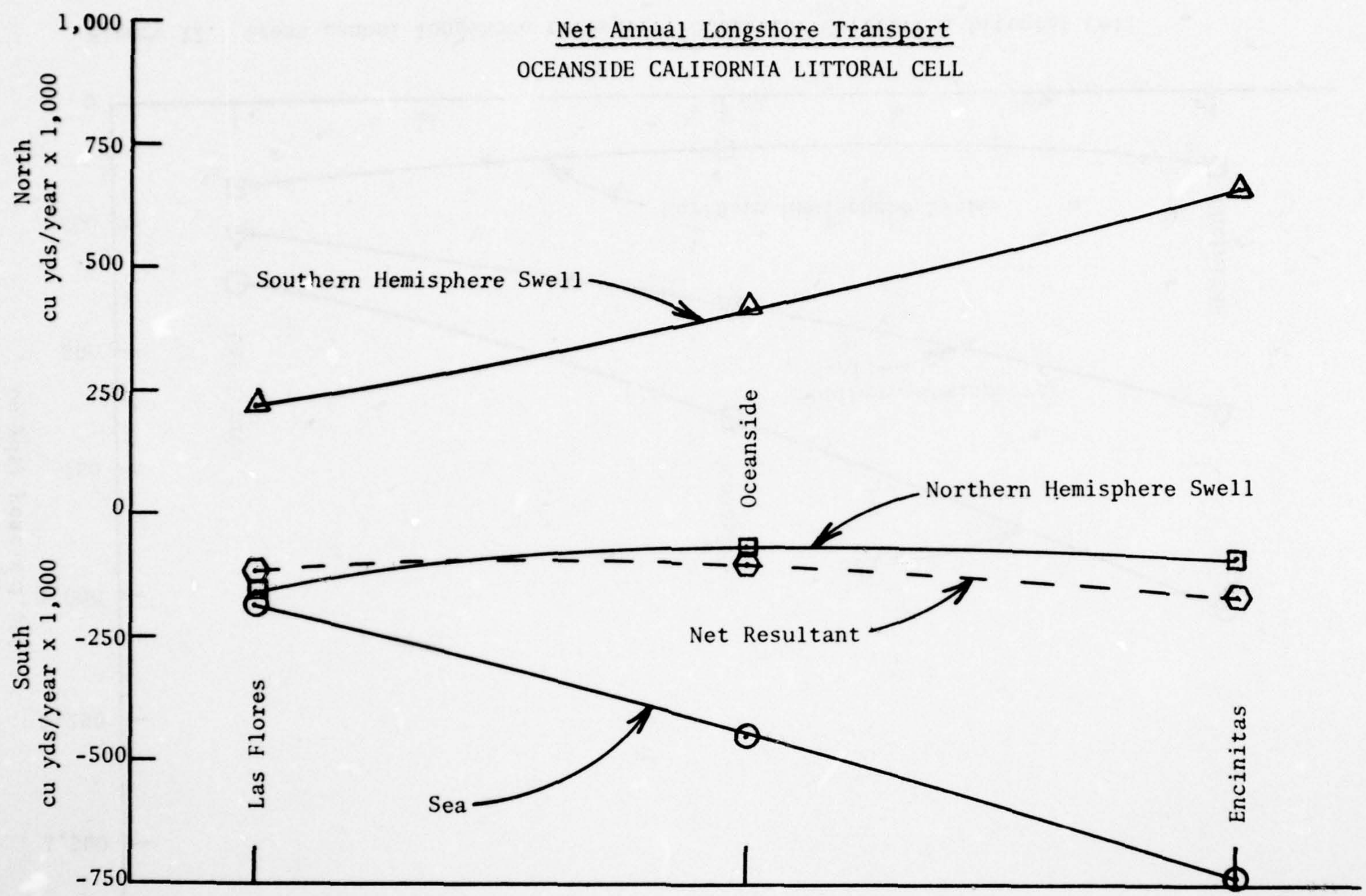

Figure 13. Net annual longshore transport, Oceanside California Littoral Cell

points of interest.

84. In order for longshore computations to provide useful information for the design and deployment of sand by-passing systems, it is necessary that a seasonal or monthly rate be determined. Accordingly, the annual quantities were decomposed into the components occurring, on the average, on a monthly basis. The total monthly longshore transport quantities are shown in Figure 14, where it can be observed that a significant amount of material moves both north and south each month of the year, except for March, April, and November, at Las Flores where only a minimal amount of material moves north.

85. The gross monthly longshore transport rates of Figure 15 reveal the more significant information regarding the amount of material that potentially can be carried into the entrance channels. The dredging records for recent years indicate that approximately 360,000 cu yd of material is required to be removed annually from the Oceanside entrance channel. This figure reveals that 160,000 cu yd of material are in transport during the months of May, June, and July. Consequently, ample material is in transport to contribute to filling of the entrance channel. A precise estimate of the mean monthly capacity of a dredging system designed to continually keep the channel open can not be made from these estimates; however, it is obvious that it must be a relatively large capacity system. The mean monthly capacity of the system can be substantially less than the gross monthly transport since some of the transport naturally by-passes the entrance channel. A more important consideration in the design of the by-passing system would involve estimates of the yearly variability of monthly and even daily transport rates from the mean in order to assure that individual storms do not overwhelm the by-passing system and shoal the entrance channel before the system can respond to these individual events. Historical dredging records should be relied upon, in concert with judgments based on the data herein, in designing a by-passing system for Oceanside.

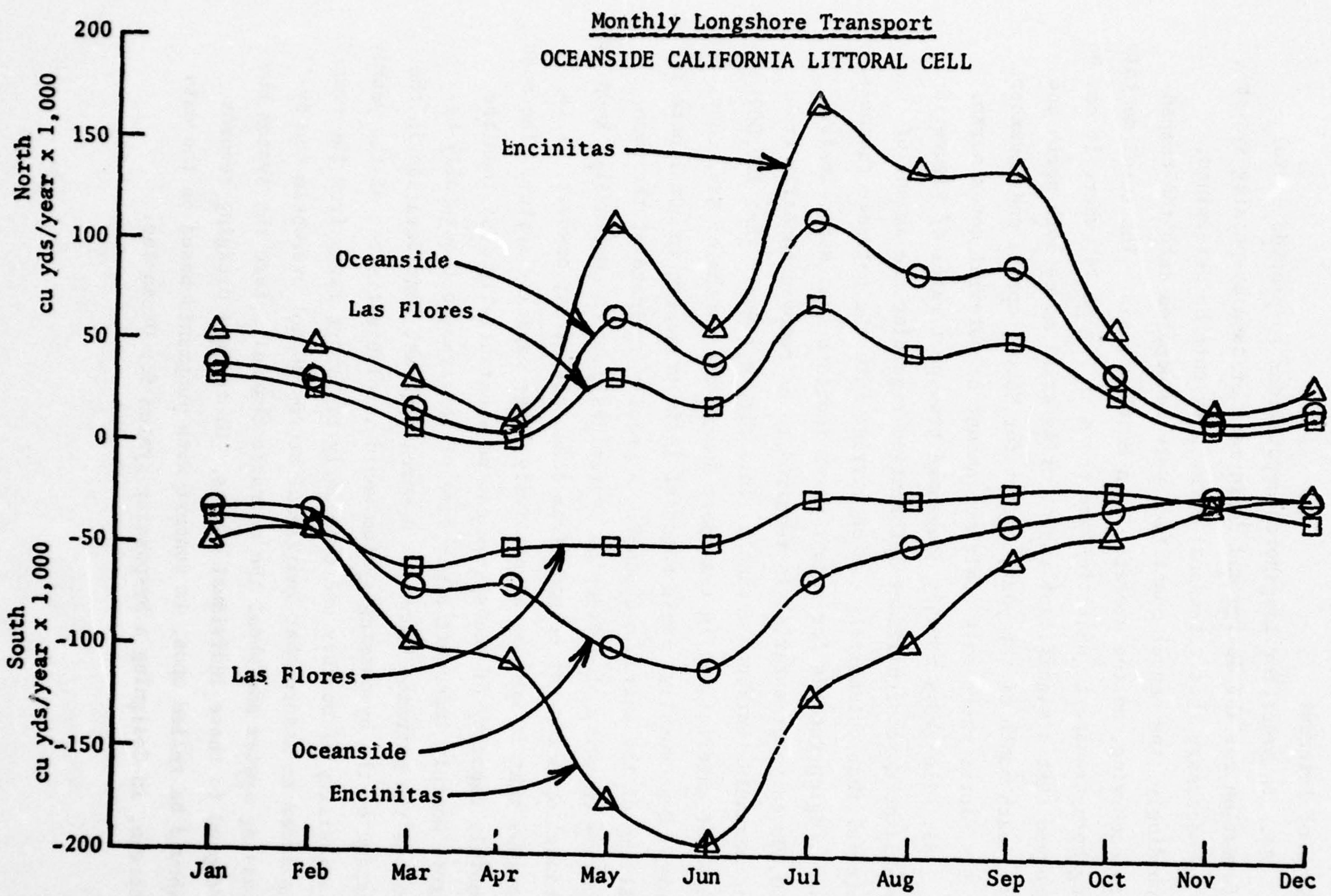

Figure 14. Monthly longshore transport, Oceanside California Littoral Cell

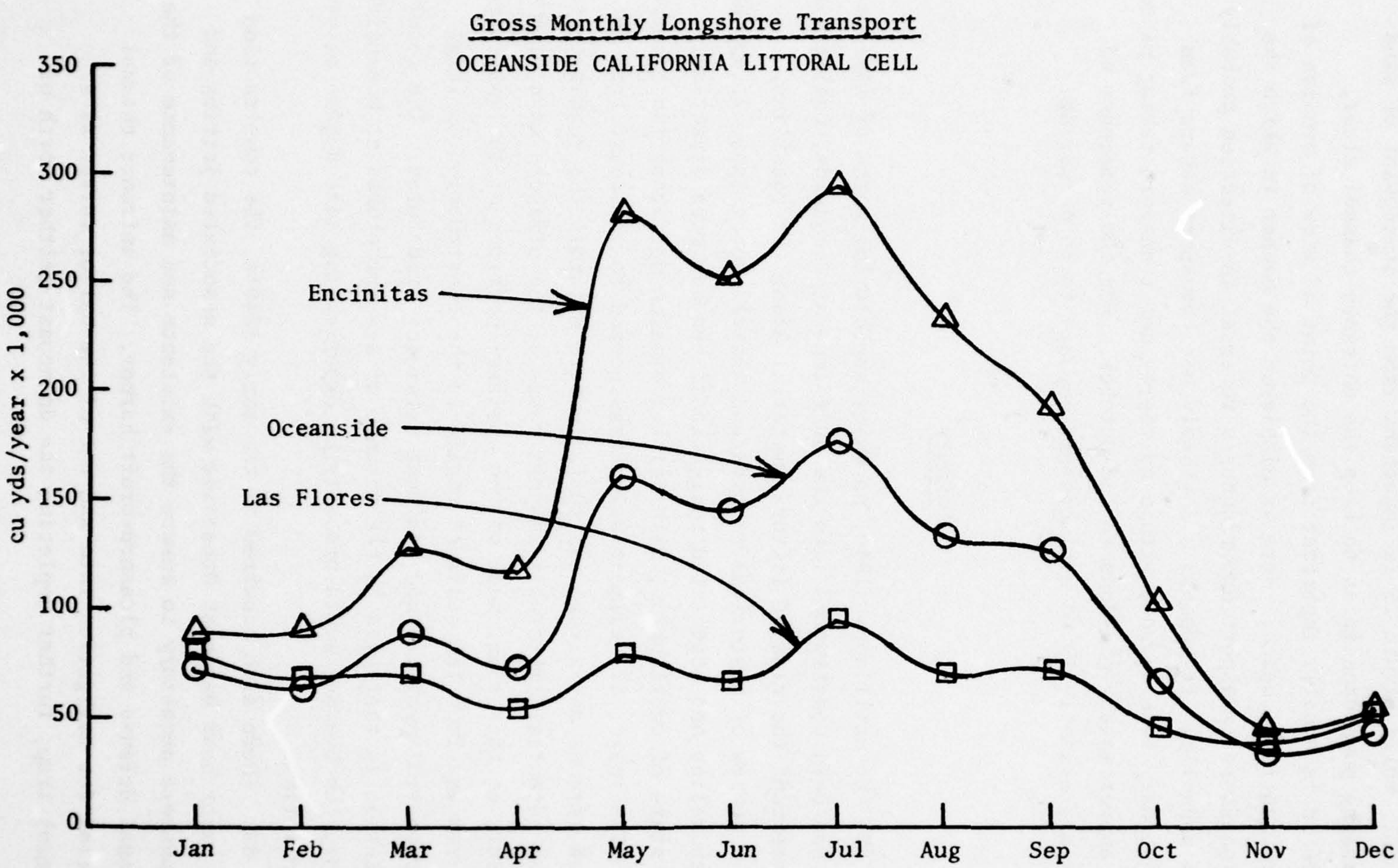

Figure 15. Gross monthly longshore transport, Oceanside California Littoral Cell

86. While Figure 15 is important from the standpoint of sand by-passing pump capacities to keep the entrance channel clear, Figure 16 is equally important from the point of view of erosion of the recreational beach. Here is displayed the manner in which the net longshore transport experiences a reversal in direction probably twice annually. It appears a southerly net transport occurs from mid-February to mid-June, with a northerly net transport taking place from approximately mid-June to mid-October. For the remainder of the year, essentially no net movement appears to be occurring.

Summary

87. Up until about 1940, no major engineering works of improvement had been constructed into the surf zone at Oceanside, California, to interrupt the flow of littoral material along the coastline. From a review of historical records and aerial photographs, it appears the shoreline and associated recreational beaches were essentially in a state of equilibrium, with neither erosion nor accretion occurring. The source of sediment being transported to the coast from the upland streams and rivers was sufficient to maintain the requirements of the potential littoral transport rates of the offshore wave climate. However, at this time, much of the upstream portions of the watersheds were removed from the sediment regime by the construction of large flood control projects and sediment retarding structures. The resulting conclusion is that even in the absence of any structures at Oceanside Harbor, the beaches would probably be experiencing some degree of erosion at this time.

88. There also occurred in the early 1940's, the construction of a major boat basin at Oceanside with the associated jetties and breakwaters necessary to ensure the existence and maintenance of the national defense and pleasure-craft harbor. The entrance channel required for navigation into and out of the harbor serves as a sediment trap, further depleting the downcoast (either north or

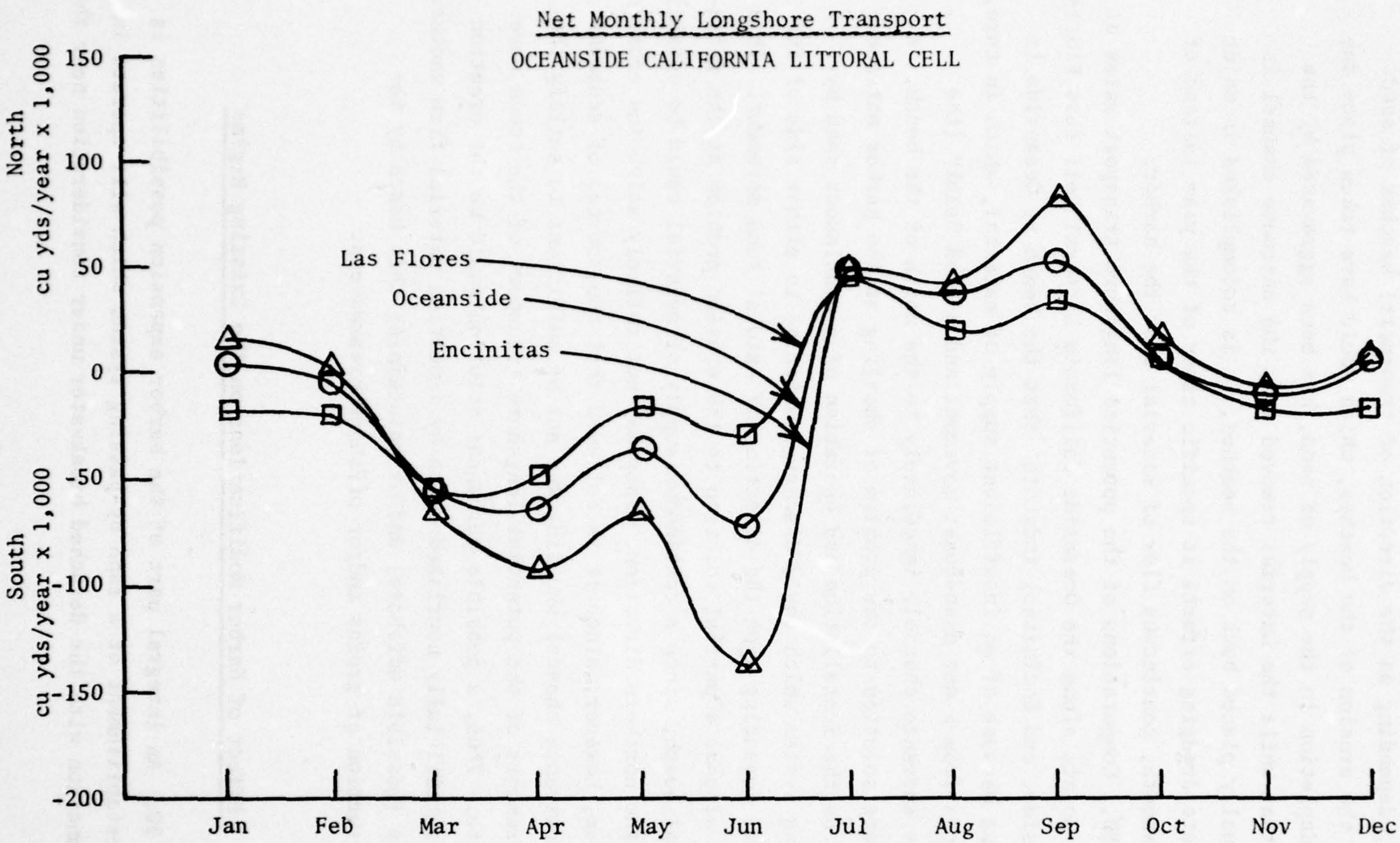

Figure 16. Net monthly longshore transport, Oceanside California Littoral Cell

south, depending on the direction of transport) beaches of sand. Thus, the erosion of the beaches, which would have taken place due to a depletion in the supply of sand, has been aggravated by the fact that while the material removed from the entrance channel is eventually placed back on the beaches, it is accomplished in major discrete dredging efforts at specific times of the year instead of in a smooth, continuous flow of material bast the harbor.

89. Computations of the potential longshore transport rates at three points along the Oceanside California Littoral Cell (Las Flores, Oceanside, and Encinitas) indicate that the beach at Oceanside is eroding because of an insufficient supply of material, which in turn, develops from a net down-coast movement and a sand "sink" (the harbor entrance channel) immediately to the north of the beach. A complete solution to the problem of shoaling at the harbor entrance would be the installation and operation of a continuous sand by-passing system which could discharge material to either side of the harbor, depending upon the direction of natural sand movement. This would also be a partial solution to the erosion problem at the recreational beach, since a continuous supply of material could be established from the northern direction. This may not entirely solve the erosion problem, however, since it is believed that the sources of sediment from entrance channel shoaling may not be sufficient to satisfy the requirements of the potential longshore transport of the ocean wave climate. Thus, a possible permanent solution would be the creation of an artificially nourished beach by importing material from another source (possible offshore) and/or maintaining this beach by the construction of groins and/or offshore breakwaters.

Effect of Harbor Modifications on the Existing Regime

90. An integral part of the harbor expansion possibilities is the establishment of a sand by-passing system which will operate in conjunction with the detached breakwater under consideration near the

entrance to the Oceanside Harbor complex. The detached breakwater near the harbor entrance is being evaluated for three specific objectives: (a) for its ability to shelter the inner harbor region from excessive wave activity; (b) so that it might reduce wave action in the entrance channel between the protecting jetties and thus improve navigation conditions; and (c) to serve as a depository for littoral material which would then be removed by the by-passing system. Under the present evaluations, the detached breakwater is intimately related to the harbor expansion plans; however, should it become evident that alternate harbor expansion plans could be optimally developed without this breakwater by a re-orientation of jetty alignment or other engineering considerations, then the detached breakwater might not be feasible for the single purpose of serving as a trap for the littoral drift. In this case, the harbor complex effects upon the littoral regime will be essentially un-affected by harbor expansion plans which might occur inside the protecting jetty system. However, jetty extensions and/or location of a sand trap to the north of the harbor would affect beach erosion, and the by-passing system must be an integral part of such plans.

Effect of Detached Breakwater (for Beach Protection) on the Existing Regime

91. A detached breakwater parallel with, and in the surf zone, in front of the recreational beach can shield that portion of the shore from the erosional effects of the wave energy. If artificial beach fill is provided behind the breakwater, it can be sufficiently protected (depending on height and location of the structure) to remain in place. If the operation and maintenance of the harbor entrance channel continues as in the past (i.e., allowing the channel to shoal and then removing the material and depositing it on a down-coast beach), for that period of time when the channel is filling there

will be no continuous flow of littoral material to the down-coast beach. The detached breakwater should continue to protect the recreational beach; however, that portion of coastline south of the breakwater will probably have a diminished source of material and could experience an increased loss of beach sand. At the same time, depending on the height and location of the structure, there may be some sand transport behind or around the structure.

92. Since it is impossible to regulate the amount of open ocean wave energy approaching the coast, the alternatives include providing a sufficient amount of source material to eliminate erosional effects, or, in the absence of a sufficient source, to structurally provide protection to selected portions of the regime. The question then arises as to which portion of the Oceanside California Littoral Cell is the more critical at the present time, and thus merits immediate restoration attention.

Effect of Harbor Modifications and Detached Breakwater (for Beach Protection) on the Existing Regime

93. The effects of the Oceanside Harbor complex on the littoral regime and the erosion of the recreational beach are inter-related to the extent that the harbor entrance channel blocks part of the flow of littoral material and thus contributes directly to the erosional problem. However, these items are not linearly additive in that the filling of the harbor entrance channel is not totally dependent on or determined by the beach erosion (i.e., although sand eroded from the beaches is deposited in the entrance channel, the entrance channel will still shoal even if the beaches were stable). Thus the harbor expansion and the construction of the detached breakwater for beach protection are relatively independent because of the fact that the harbor effects are already partially incorporated into the littoral regime phenomena. It is apparent that the detached breakwater near

the entrance channel (or other major structural changes outside the limits of the present jetties) must be operated in conjunction with a sand by-passing system in order to not contribute to the erosional problem down-coast south of the protected beach. At the same time, the detached breakwater for beach protection may transfer a portion of the erosional problem further south, as has been observed in other locations. The protection of the recreational beach by the detached breakwater should not have adverse effects on the operation of the harbor complex.

Physical Model Necessity

94. The problems associated with the Oceanside Harbor complex and the recreational beach erosion are extremely difficult to investigate analytically. A much better understanding and appreciation of the coastal processes at Oceanside will be obtained upon the completion of a physical model study of the harbor complex and adjacent beaches currently underway by the U. S. Army Engineer Waterways Experiment Station. There are many potential alternative solutions to the problems, and it is not at all clear which solution is optimal, or even which one will function to solve the problems. Completion of the hydraulic model investigation will shed considerable insight into which solution is optimal.

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Table 1

Dredging History

OCEANSIDE, CALIFORNIA, HARBOR AND ENTRANCE CHANNEL

Starting Date	Completion Date	Disposal Area	Approximate Dredge Quantity, cu yd
May 1942	Aug 1944	Inland Fill	1,500,000
Apr 1945	Jun 1945	Inland Fill	219,000
Apr 1957	May 1958	6th to 9th St.	800,000
Aug 1960	Aug 1960	6th to 9th St.	17,500
Sep 1960	Oct 1960	6th to 9th St.	23,700
Jan 1961	May 1961	6th to 9th St.	222,350
Aug 1961	Dec 1961	6th to 9th St.	258,800
Mar 1962	Feb 1963	9th St. to Loma Alta Cr.	3,810,700
Aug 1965	Aug 1965	9th to 3rd St.	111,400
Mar 1966	Apr 1966	3rd St. to Minn. Ave.	684,000
Jul 1967	Jul 1967	3rd to Tyson St.	177,900
Mar 1968	Jun 1968	San Luis Rey to Wis. Ave.	433,900
Jul 1969	Sep 1969	San Luis Rey to 3rd St.	353,000
Apr 1971	Jul 1971	3rd St. to Wis. Ave.	551,900
Jun 1973	Jul 1973	Tyson to Hays St.	434,100
Oct 1974	Jan 1975	Pine to Witherby St.	559,750
May 1976	Jul 1976	Ash to Witherby St.	550,000
Aug 1977	Feb 1978	Ash to Witherby St.	318,550

Table 2

Summary of
Potential Longshore Transport Computations

LAS FLORES, CALIFORNIA

Month	Sea + North	Sea - South	Northern Swell + North	Northern Swell - South	Southern Swell North	Southern Swell - South	Sum + North	Sum - South	Net + North	Net - South	Gross
Jan	30,238	22,286	729	26,466	0	0	30,967	48,752		17,785	79,719
Feb	21,980	20,989	1,742	22,771	0	0	23,722	43,760		20,038	67,482
Mar	6,896	42,456	584	19,783	0	0	7,480	62,239		54,759	69,719
Apr	1,844	36,601	624	13,910	0	0	2,468	50,511		48,043	52,979
May	60	34,025	158	8,811	31,400	5,149	31,618	47,985		16,367	79,603
Jun	9	36,438	0	9,363	18,230	2,642	18,239	48,443		30,204	66,682
Jul	0	13,334	0	7,708	69,648	5,074	69,648	26,126	43,522		95,774
Aug	0	12,774	4	8,140	45,057	5,416	45,061	26,330	18,731		71,391
Sep	40	11,204	222	5,566	52,265	3,892	52,527	20,662	31,865		73,189
Oct	1,086	11,980	51	5,864	25,227	1,957	26,364	19,801	6,563		46,165
Nov	9,248	13,206	566	15,351	0	0	9,814	28,557		18,743	38,371
Dec	16,828	15,050	854	20,322	0	0	17,682	35,372		17,690	53,054
Annual	88,229	270,353	5,534	164,055	241,827	24,130	335,590	458,538	100,681	223,629	794,128
Net		182,124		158,521	217,697			122,948		122,948	

Table 3

Summary of
Potential Longshore Transport Computations

OCEANSIDE, CALIFORNIA

	Sea		Northern Swell		Southern Swell		Sum		Net		Gross
	+	-	+	-		-	+	-	+	-	
Month	North	South	North	South	North	South	North	South	North	South	Gross
Jan	35,501	25,281	1,741	9,148	0	0	37,242	34,429	2,813		71,671
Feb	26,188	25,188	3,544	8,759	0	0	29,732	33,947		4,215	63,679
Mar	9,788	63,737	5,977	8,080	0	0	15,765	71,817		56,052	87,582
Apr	2,993	61,542	1,735	6,896	0	0	4,728	68,438		63,710	73,166
May	88	90,521	180	8,265	61,979	0	62,247	98,786		36,539	161,033
Jun	34	99,024	0	9,852	36,889	0	36,923	108,876		71,953	145,799
Jul	9	57,129	0	7,804	112,906	0	112,915	64,933	47,982		177,848
Aug	0	42,133	8	6,105	84,664	0	84,672	48,238	36,434		132,910
Sep	63	33,445	375	3,472	89,151	0	89,589	36,917	52,672		126,506
Oct	1,307	27,342	43	2,970	35,147	0	36,497	30,312	6,185		66,809
Nov	10,389	16,595	1,127	6,541	0	0	11,516	23,136		11,620	34,652
Dec	17,244	15,418	1,546	7,841	0	0	18,790	23,259		4,469	42,049
Annual	103,604	557,355	16,276	85,733	420,736	0	540,616	643,088	146,086	248,558	1,183,704
Net		453,751		69,457	420,736			102,472		102,472	

Table 4

Summary of
Potential Longshore Transport Computations

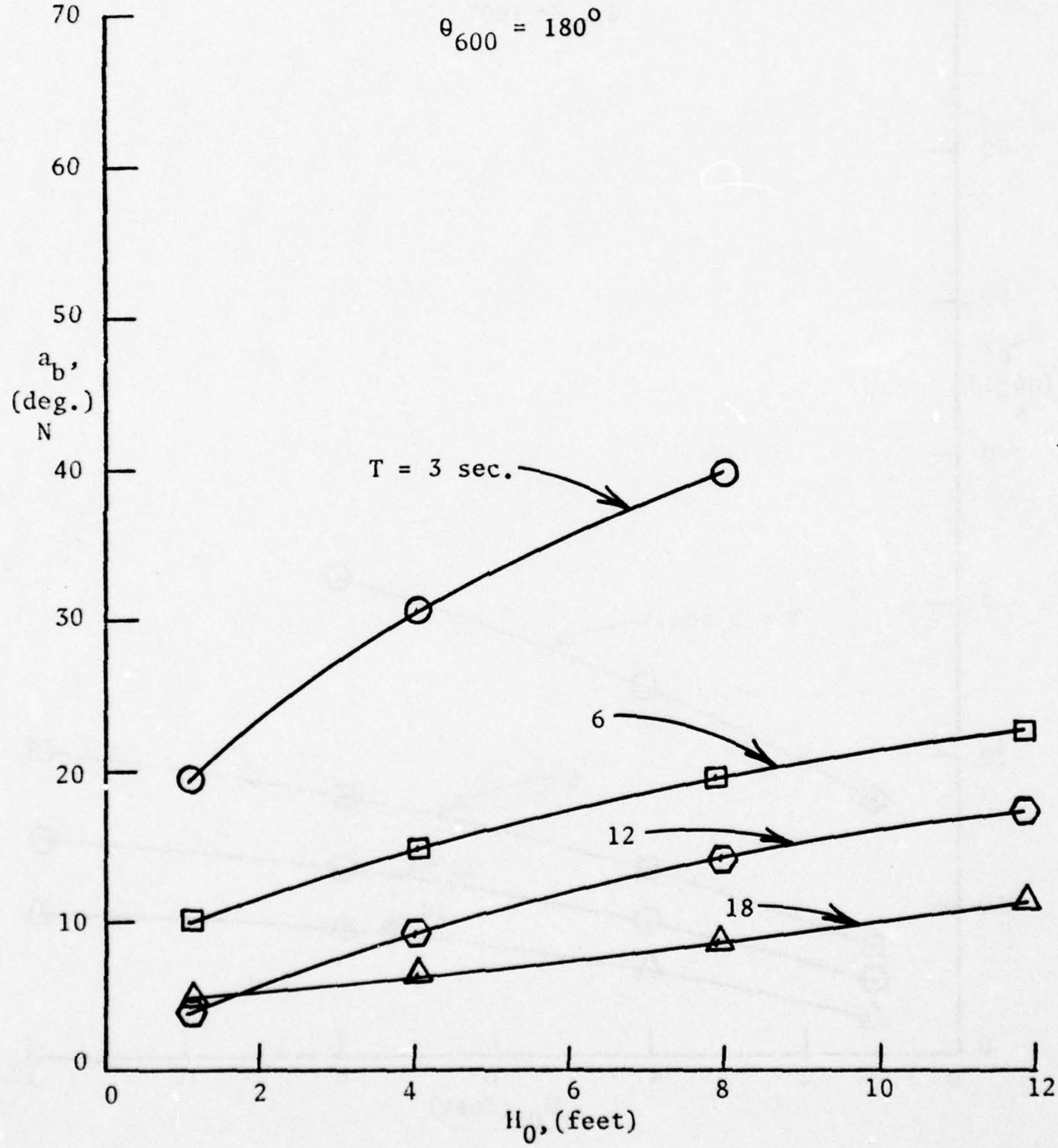
ENCINITAS, CALIFORNIA

	Sea		Northern Swell		Southern Swell		Sum		Net		Gross
	+	-	+	-		-	+	-	+	-	
Month	North	South	North	South	North	South	North	South	North	South	Gross
Jan	47,049	28,152	5,241	8,231	0	0	52,290	36,383	15,907		88,673
Feb	40,081	34,755	6,985	8,175	0	0	47,066	42,930	4,136		89,996
Mar	18,081	87,479	12,518	9,455	0	0	30,599	96,934		66,335	127,533
Apr	7,895	96,636	3,637	9,239	0	0	11,532	105,875		94,343	117,407
May	195	158,500	214	15,908	107,476	0	107,885	174,408		66,523	282,293
Jun	947	176,484	49	18,309	56,348	0	57,344	194,793		137,449	252,137
Jul	21	107,353	0	16,092	170,414	0	170,435	123,445	46,990		293,880
Aug	0	84,647	7	11,538	136,065	0	136,072	96,185	39,887		232,257
Sep	93	49,177	541	5,705	135,339	0	135,973	54,882	81,091		190,855
Oct	2,012	39,916	83	3,672	56,231	0	58,326	43,588	14,738		101,914
Nov	16,391	20,233	1,882	6,018	0	0	18,273	26,251		7,978	44,524
Dec	27,205	18,398	3,331	6,434	0	0	30,536	24,832	5,704		55,368
Annual	159,970	901,730	34,488	118,776	661,873	0	856,331	1,020,506	208,453	372,628	1,876,837
Net		741,760		84,288	661,873			164,175		164,175	

APPENDIX I: EFFECT OF PERIOD, SHELTERED DEEP WATER WAVE HEIGHT, AND ANGLE OF APPROACH ON BREAKER ANGLE, LAS FLORES, CALIFORNIA

LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



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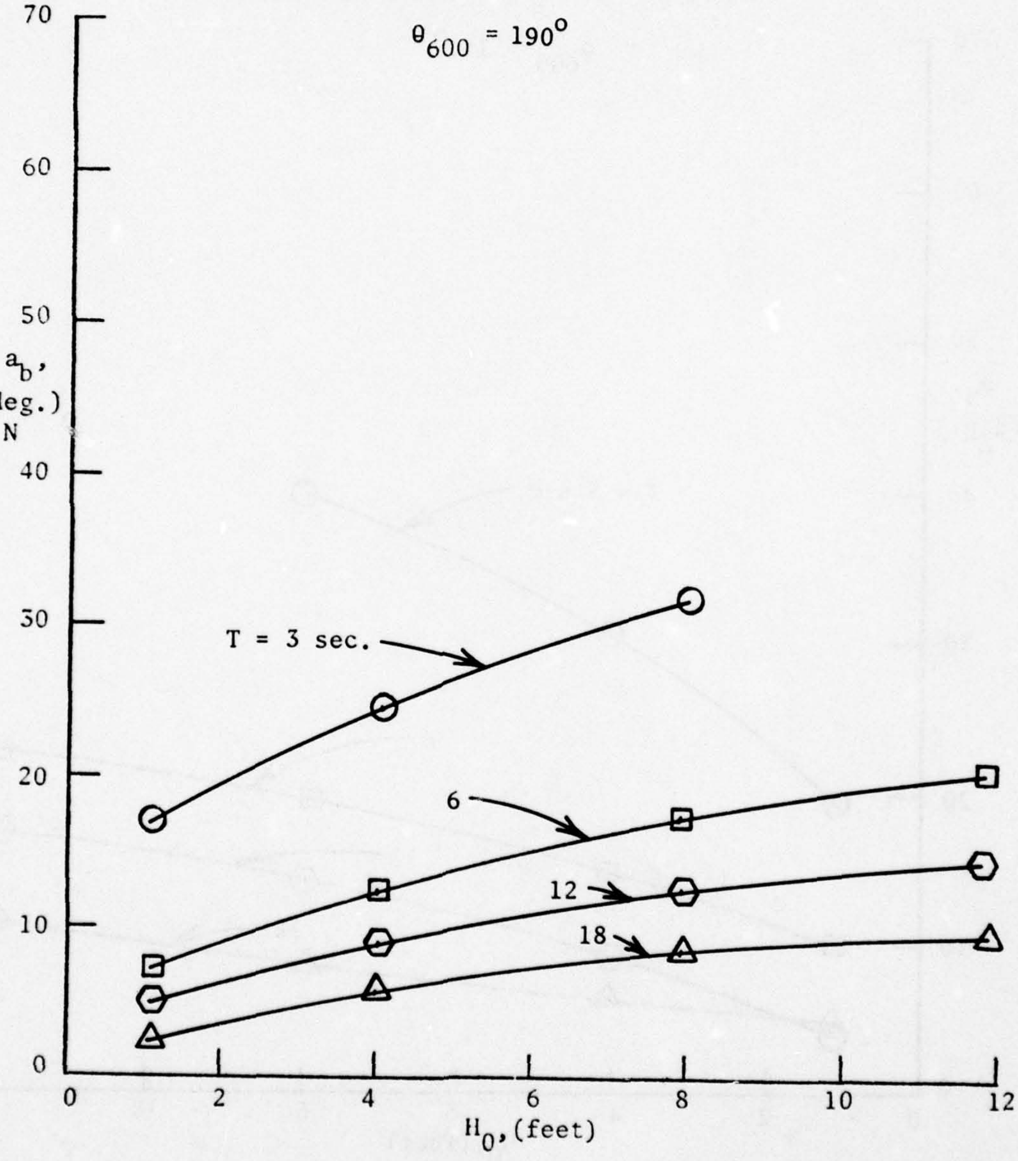
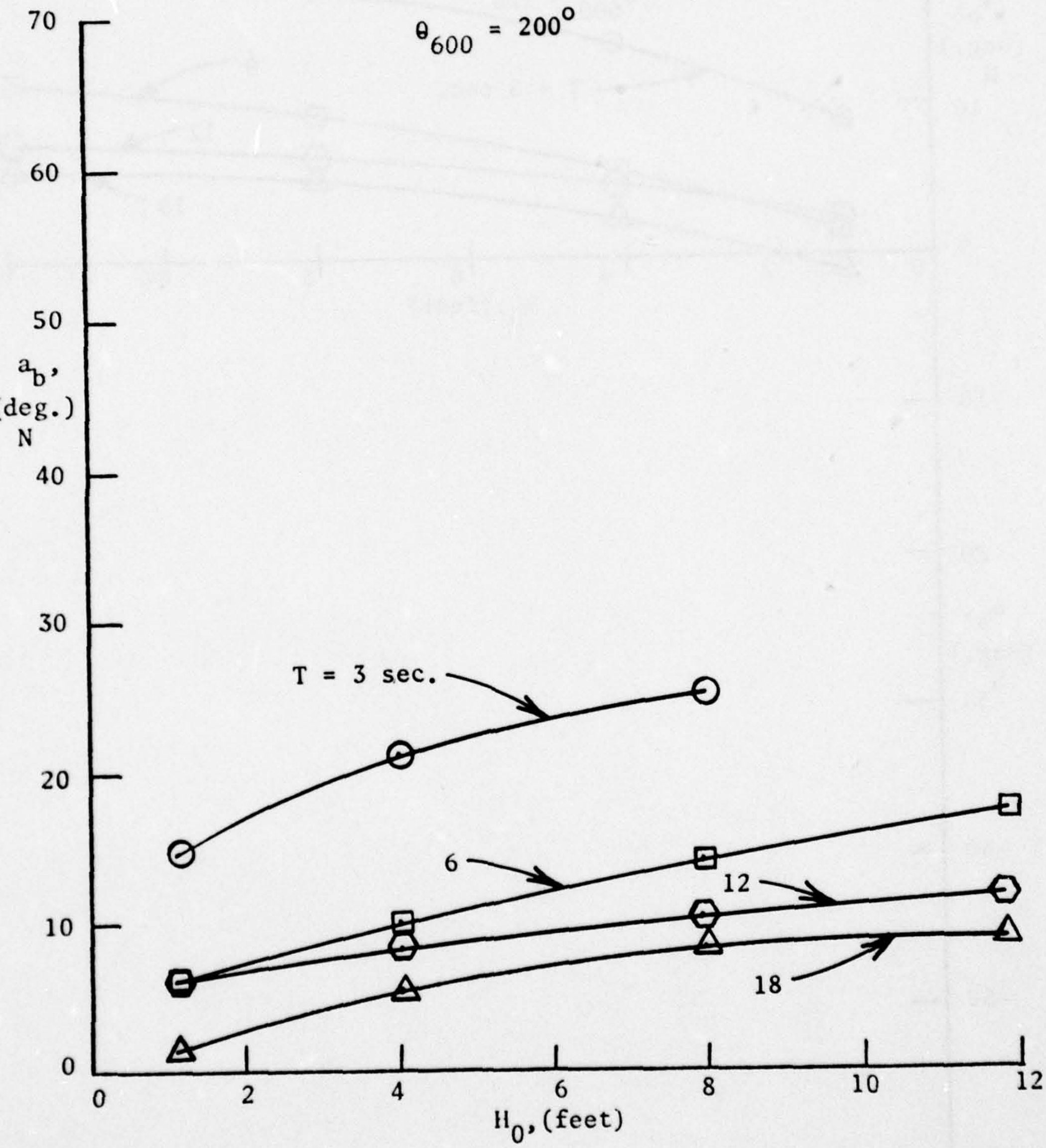
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



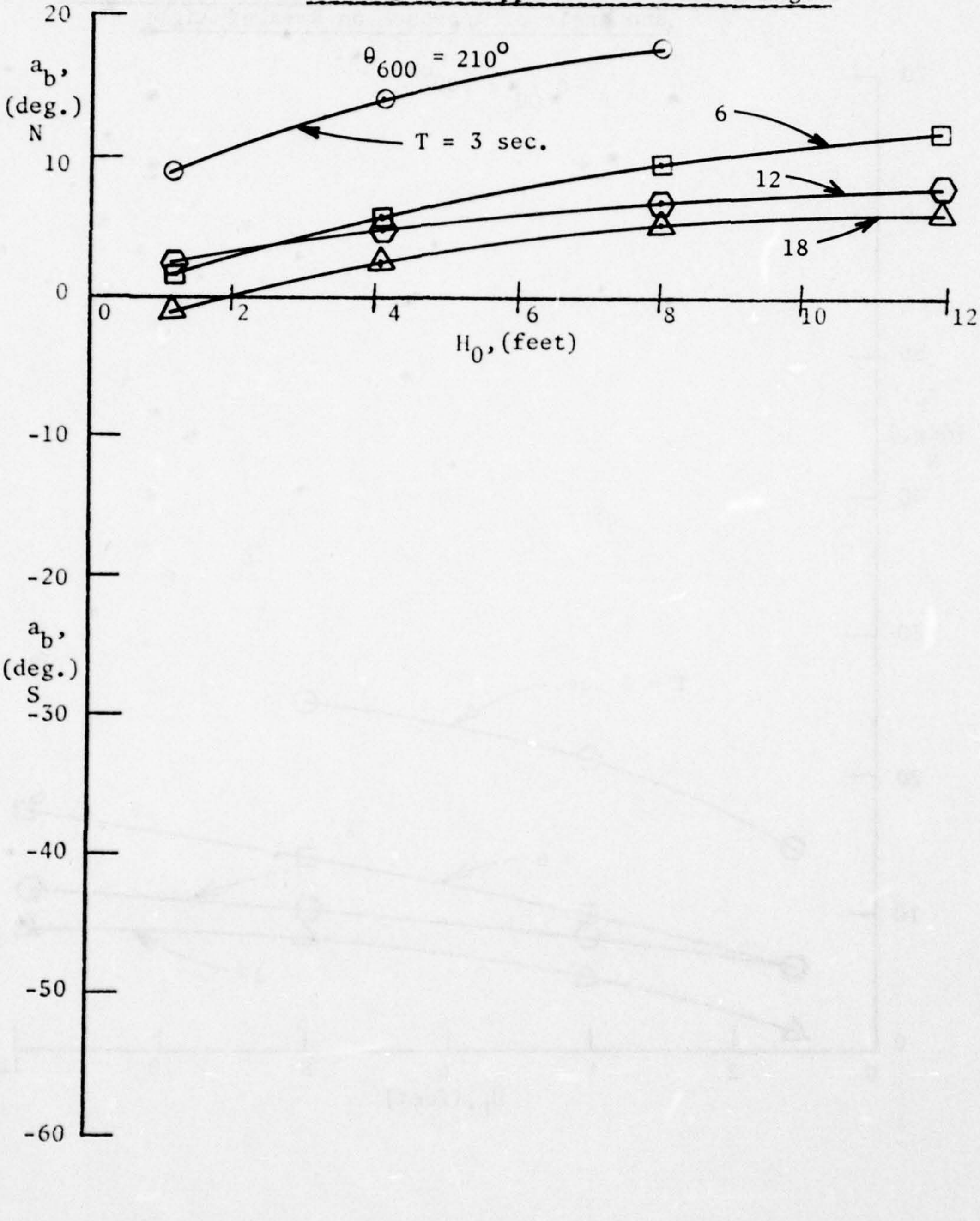
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



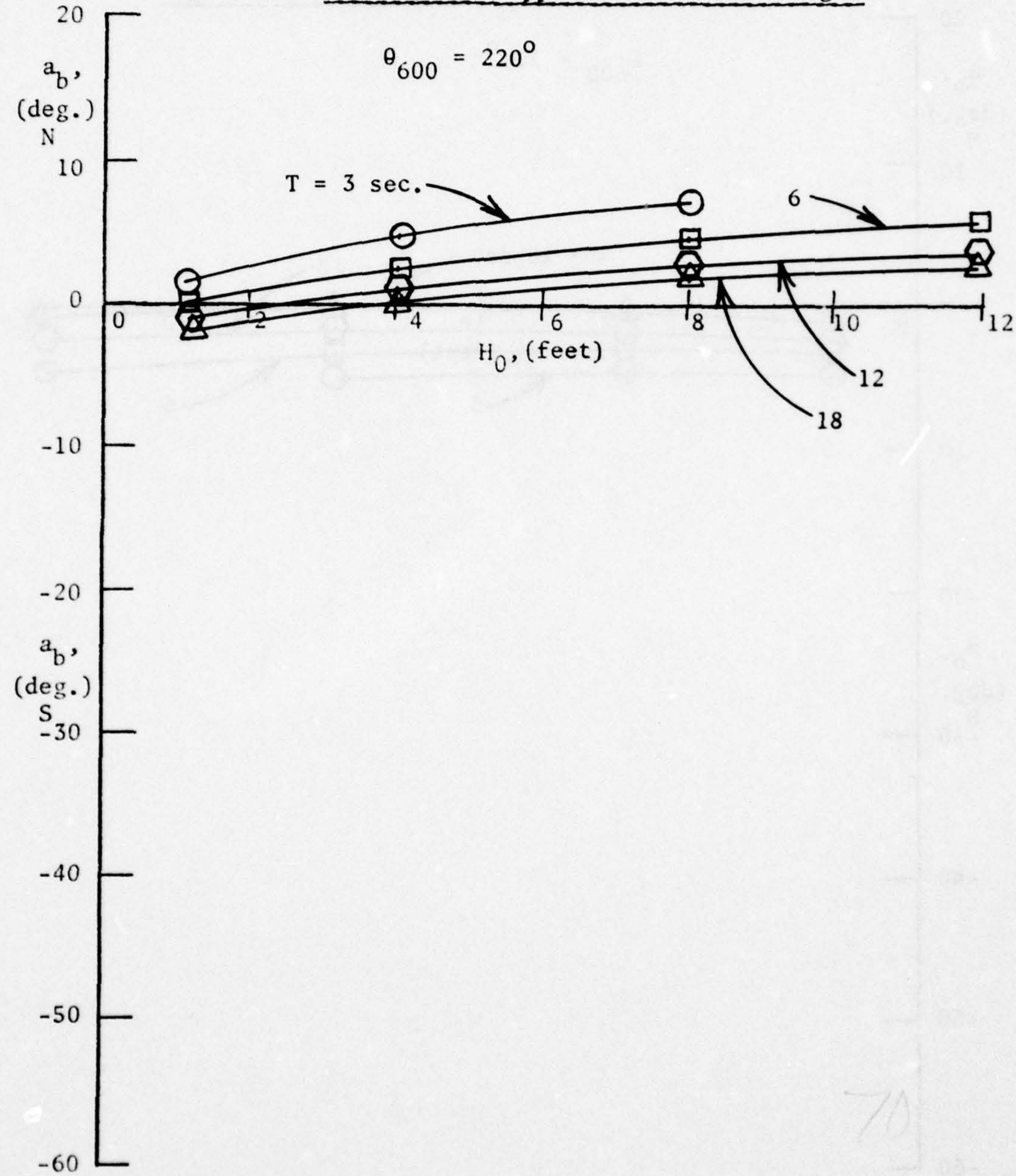
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



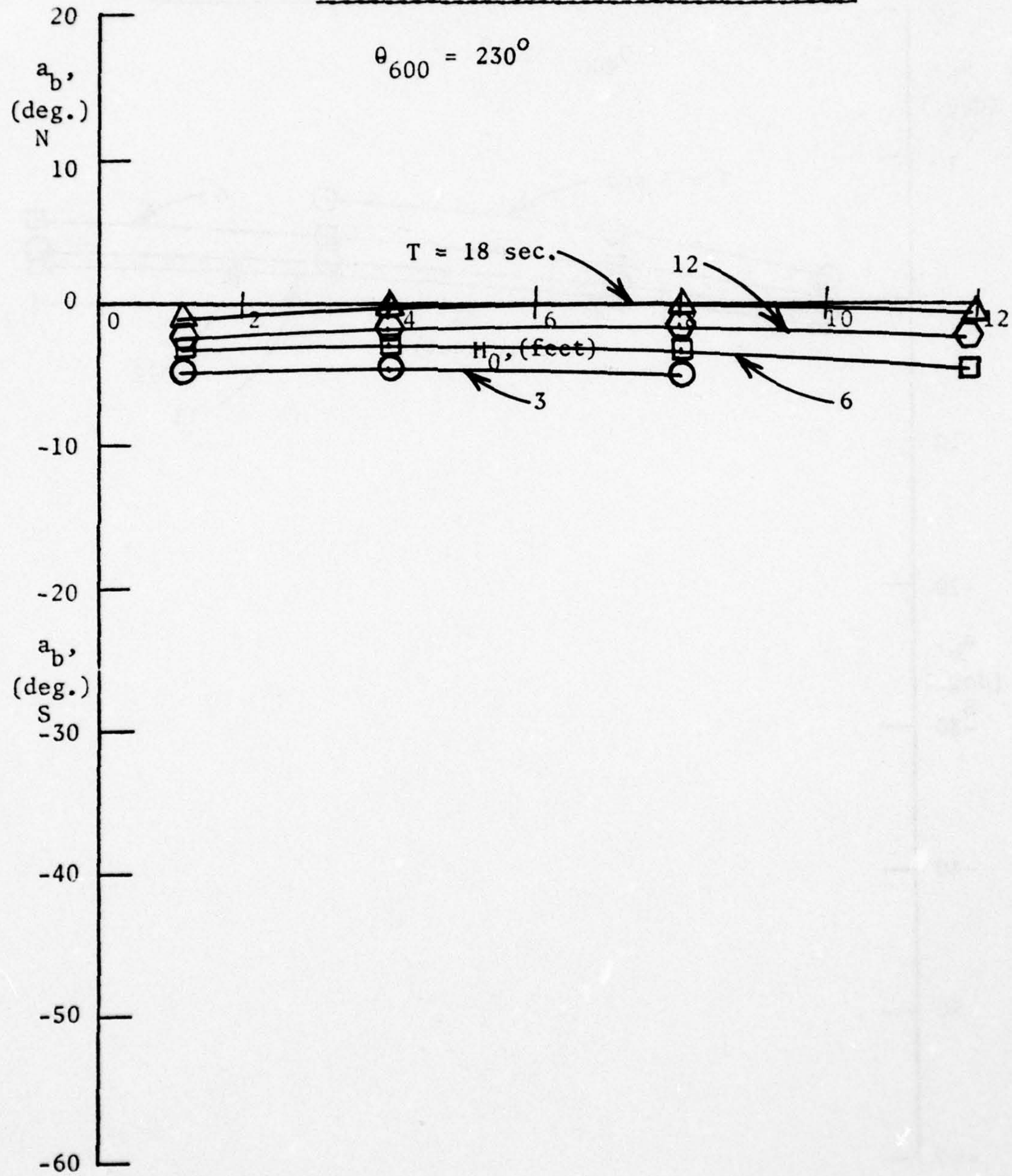
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



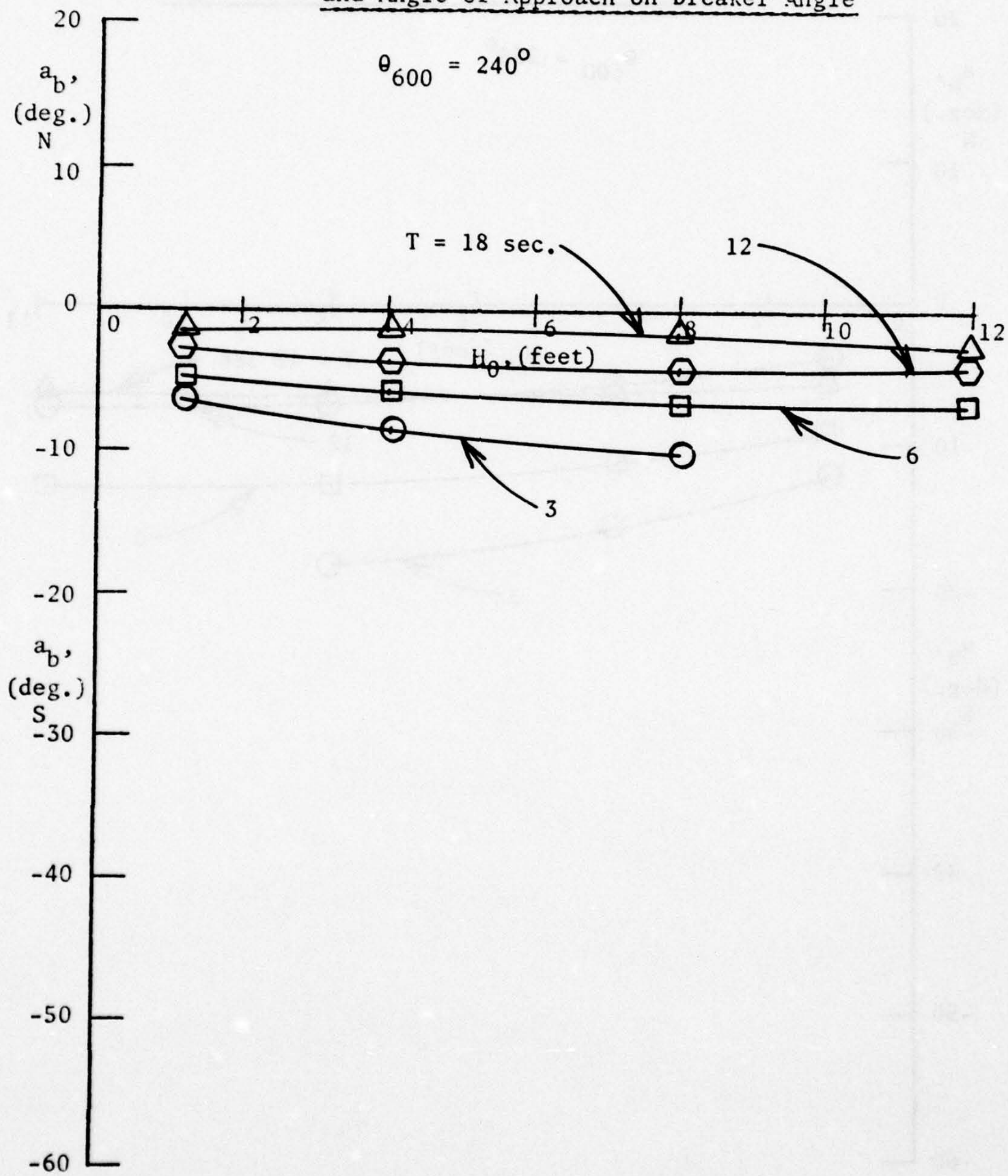
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



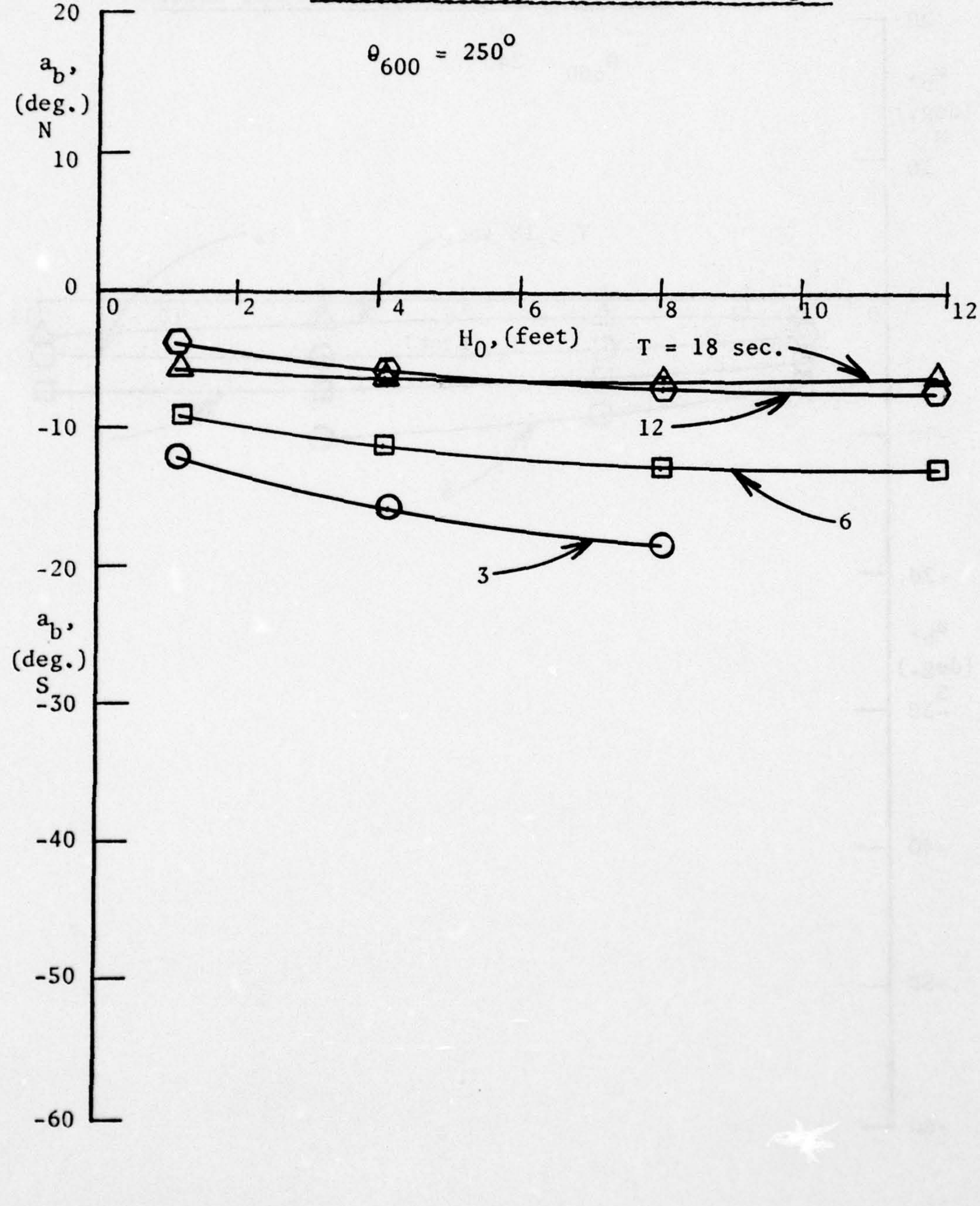
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



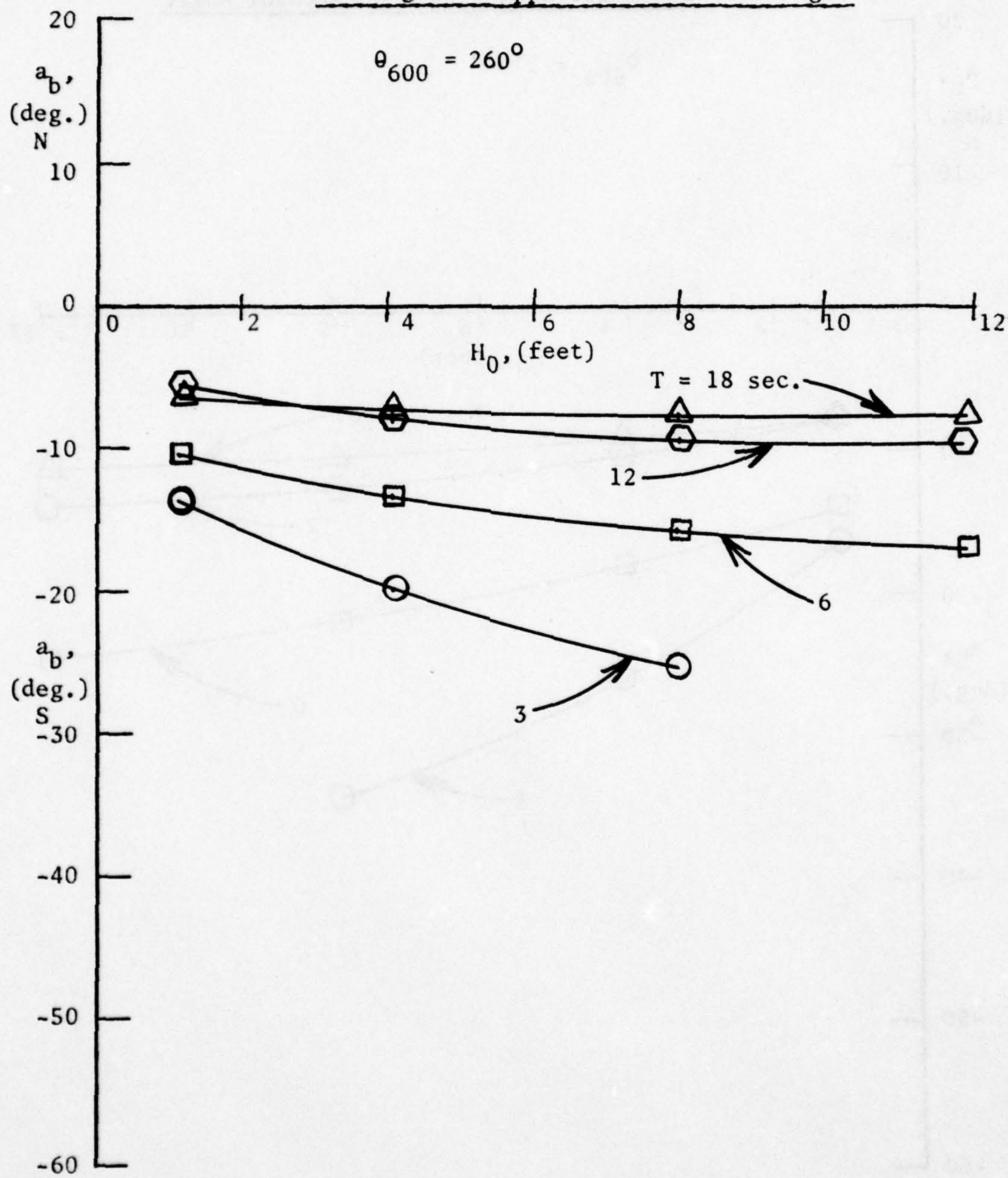
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



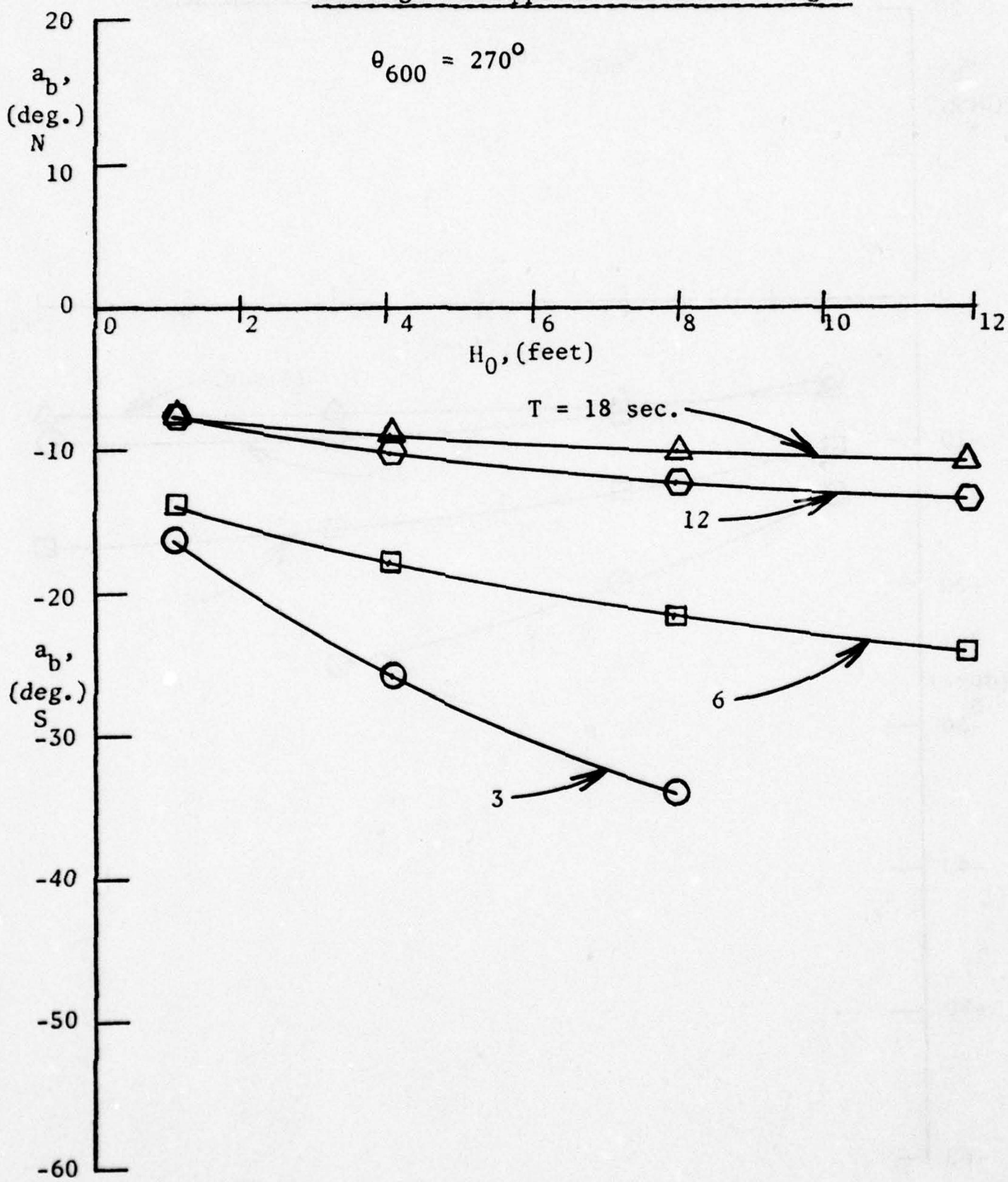
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



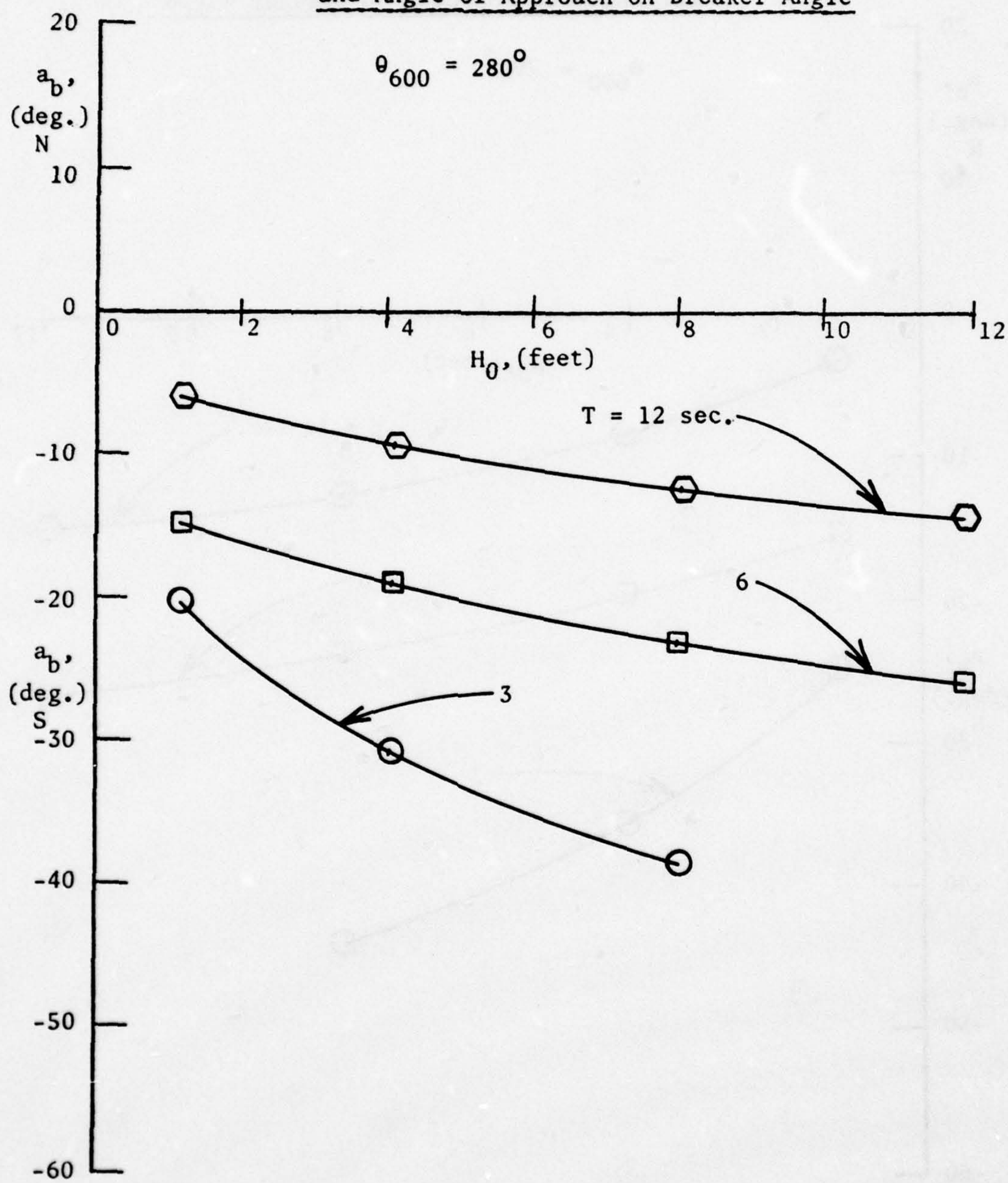
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



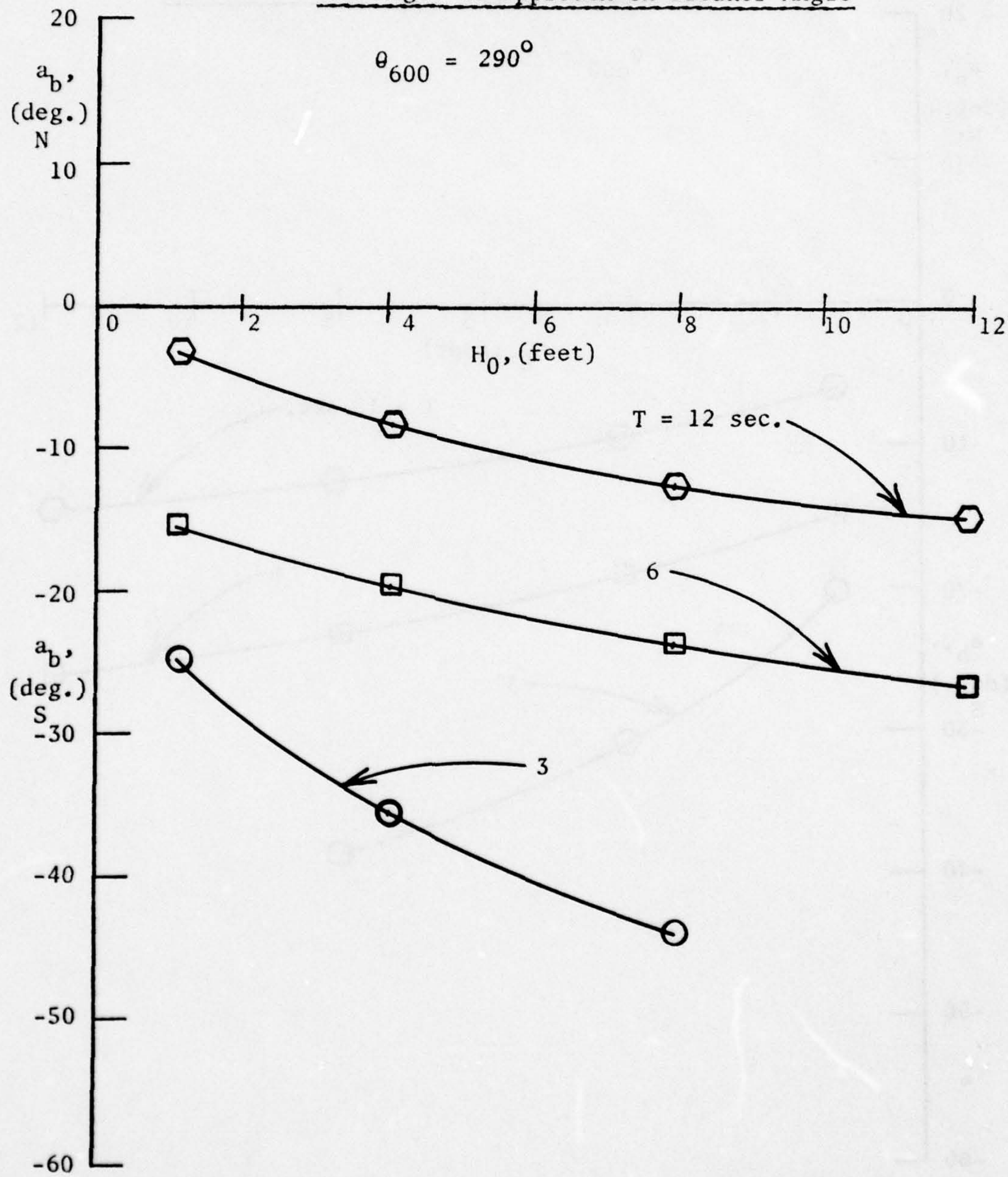
LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



LAS FLORES, CALIFORNIA

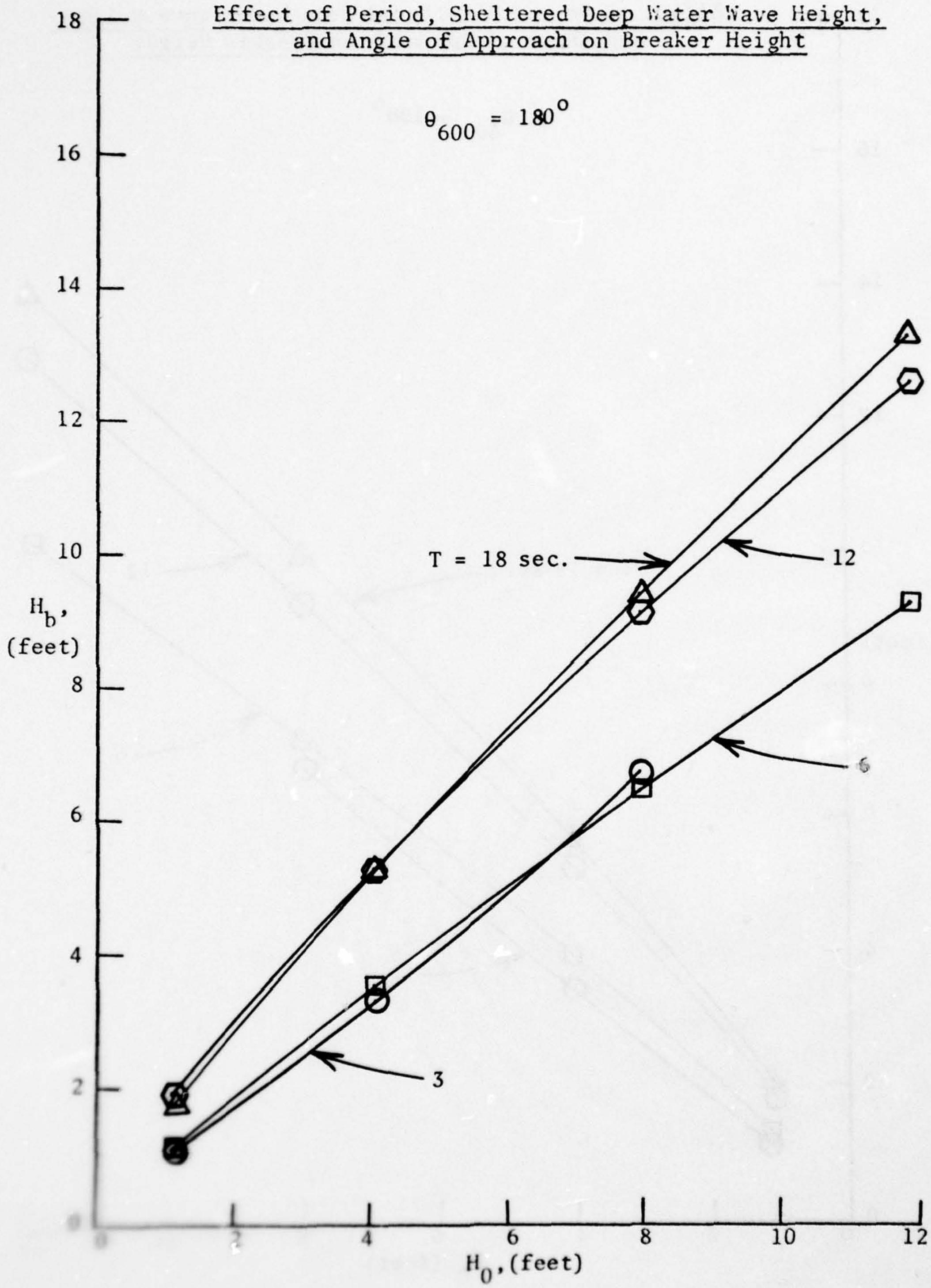
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle

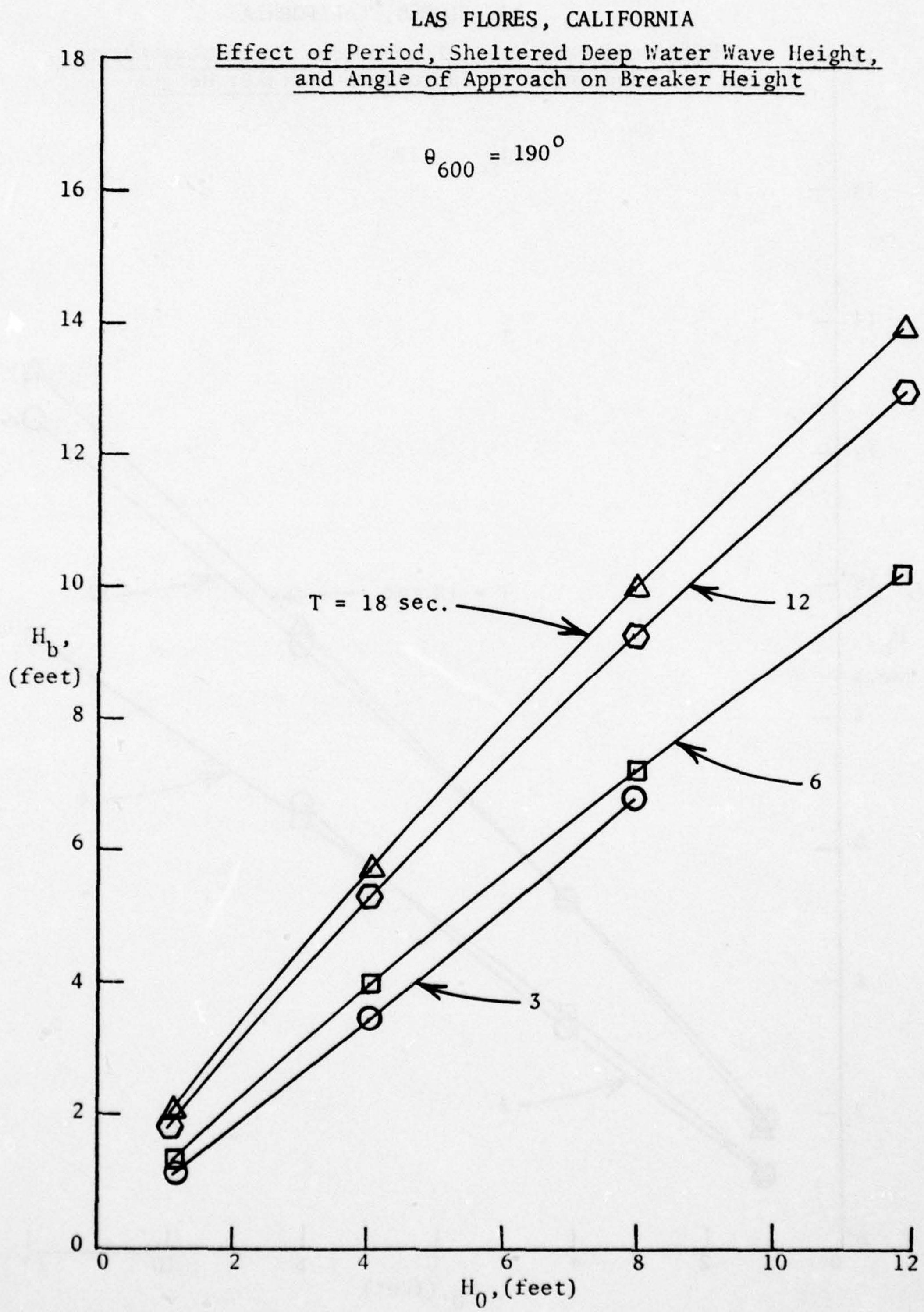


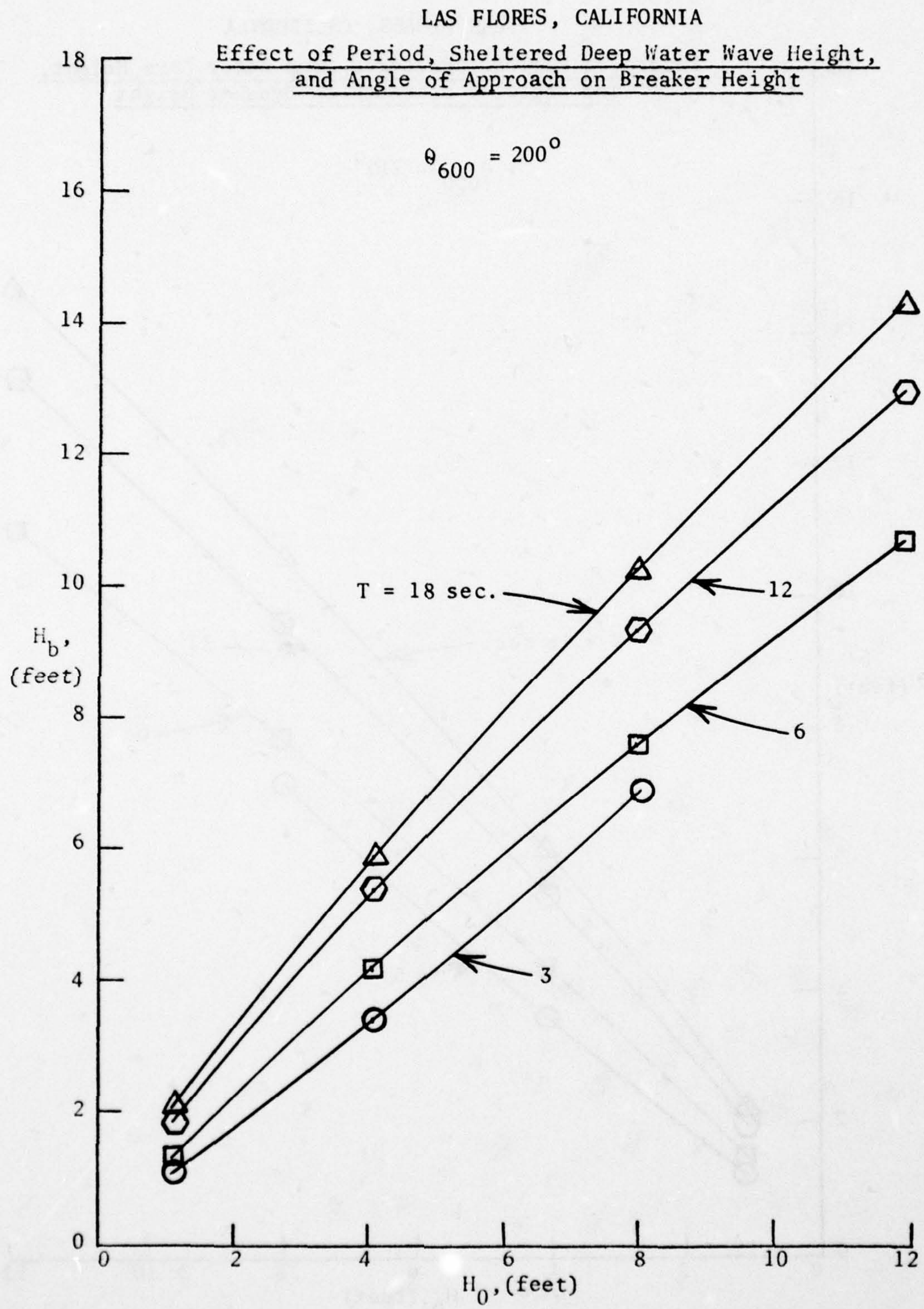
APPENDIX II: EFFECT OF PERIOD, SHELTERED DEEP WATER WAVE HEIGHT, AND ANGLE OF APPROACH ON BREAKER HEIGHT, LAS FLORES, CALIFORNIA

LAS FLORES, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height

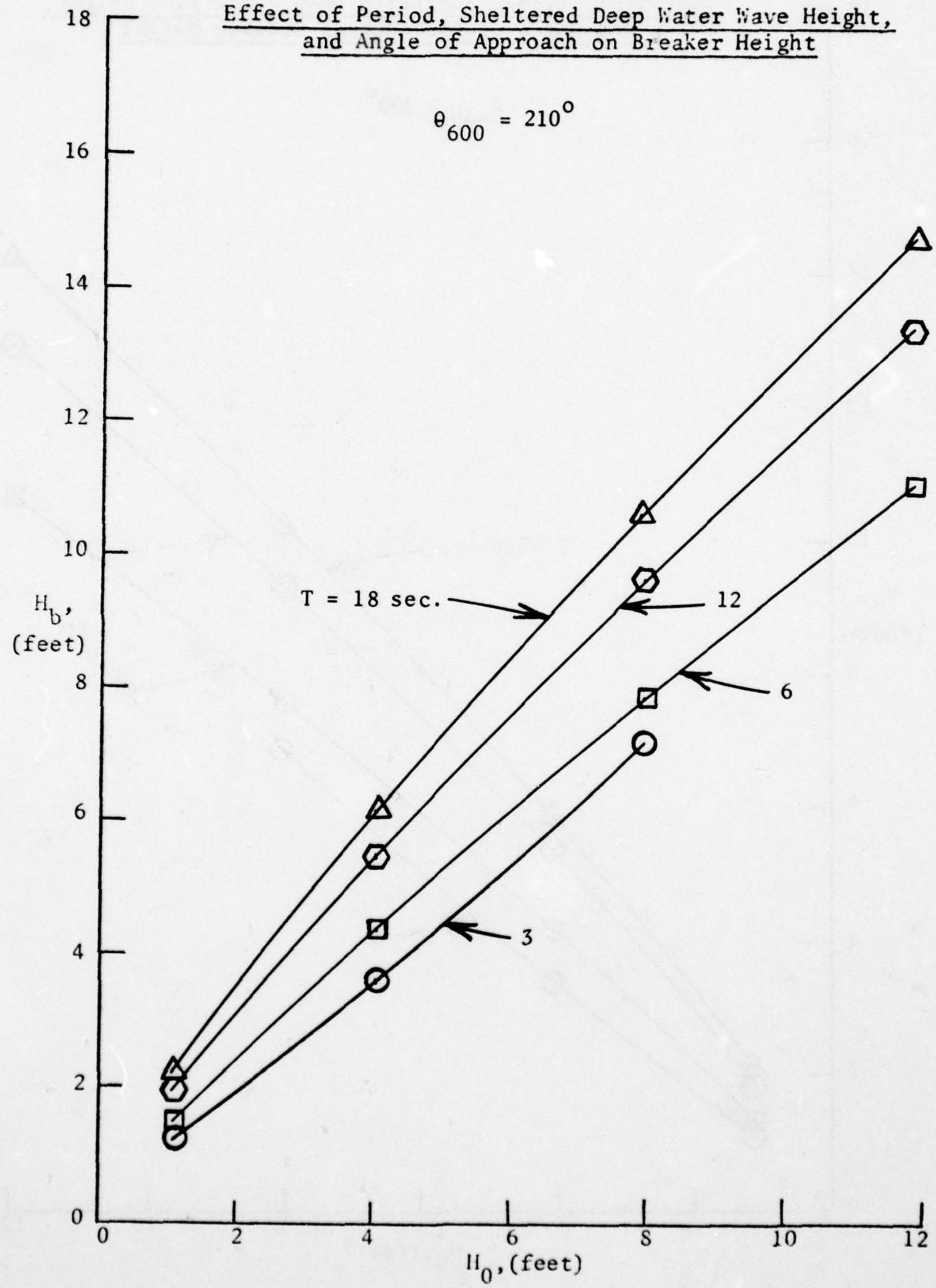



LAS FLORES, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
θ600 = 190°
T = 18 sec.
12
6
3
Hb, (feet)
H0, (feet)
0
2
4
6
8
10
12
14
16
18


LAS FLORES, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 200^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

LAS FLORES, CALIFORNIA

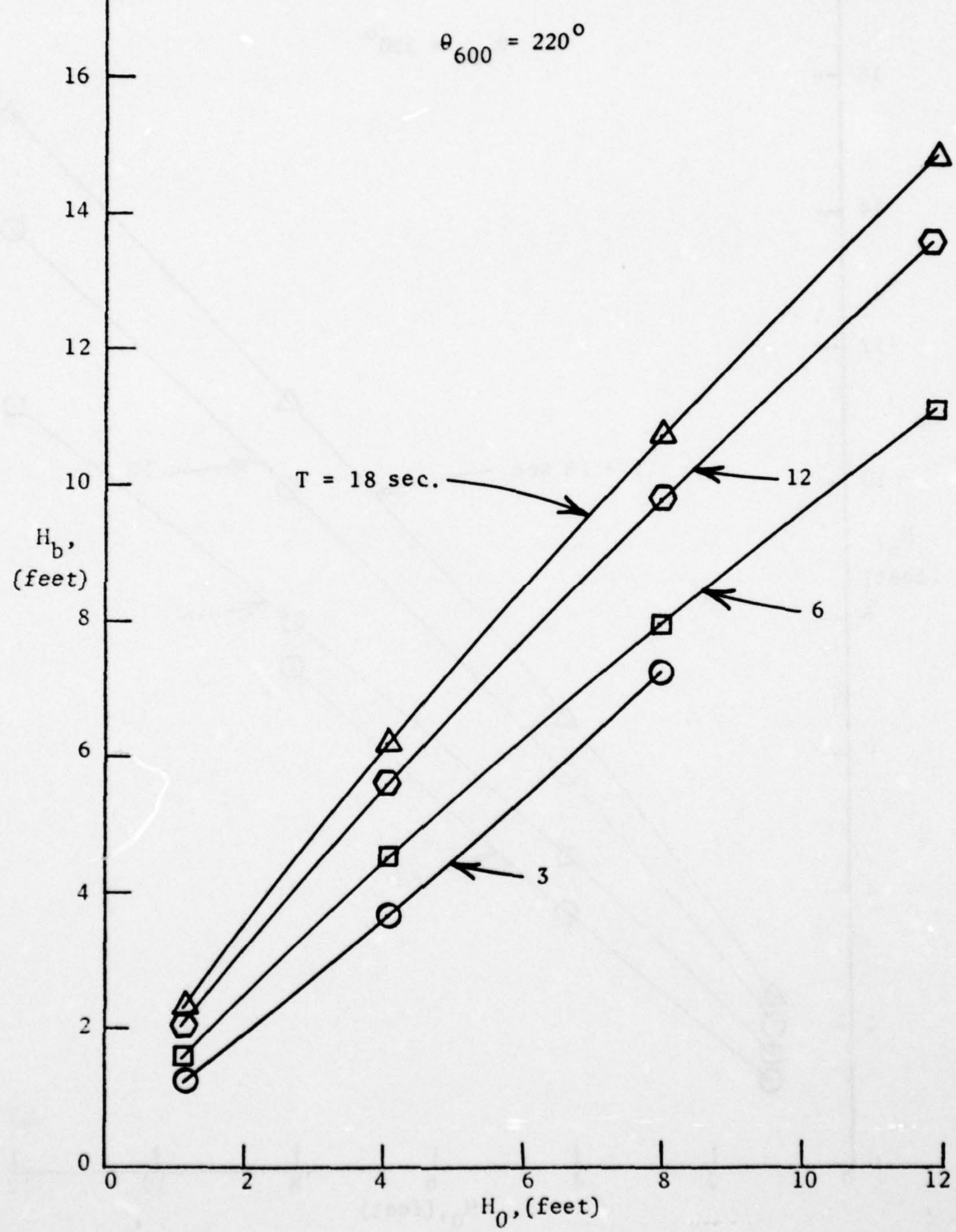
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height



LAS FLORES, CALIFORNIA

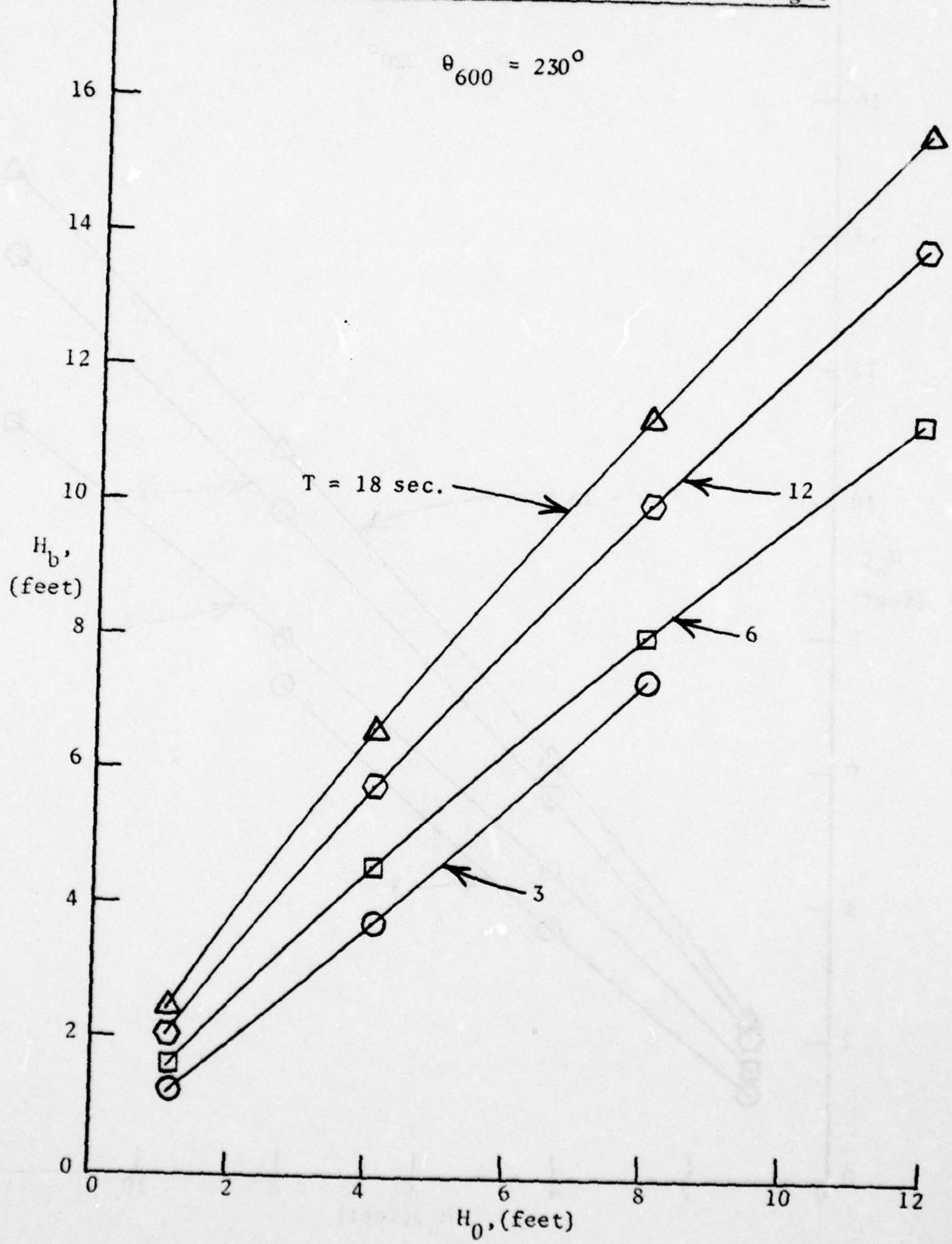
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height

$\theta_{600} = 220^{\circ}$



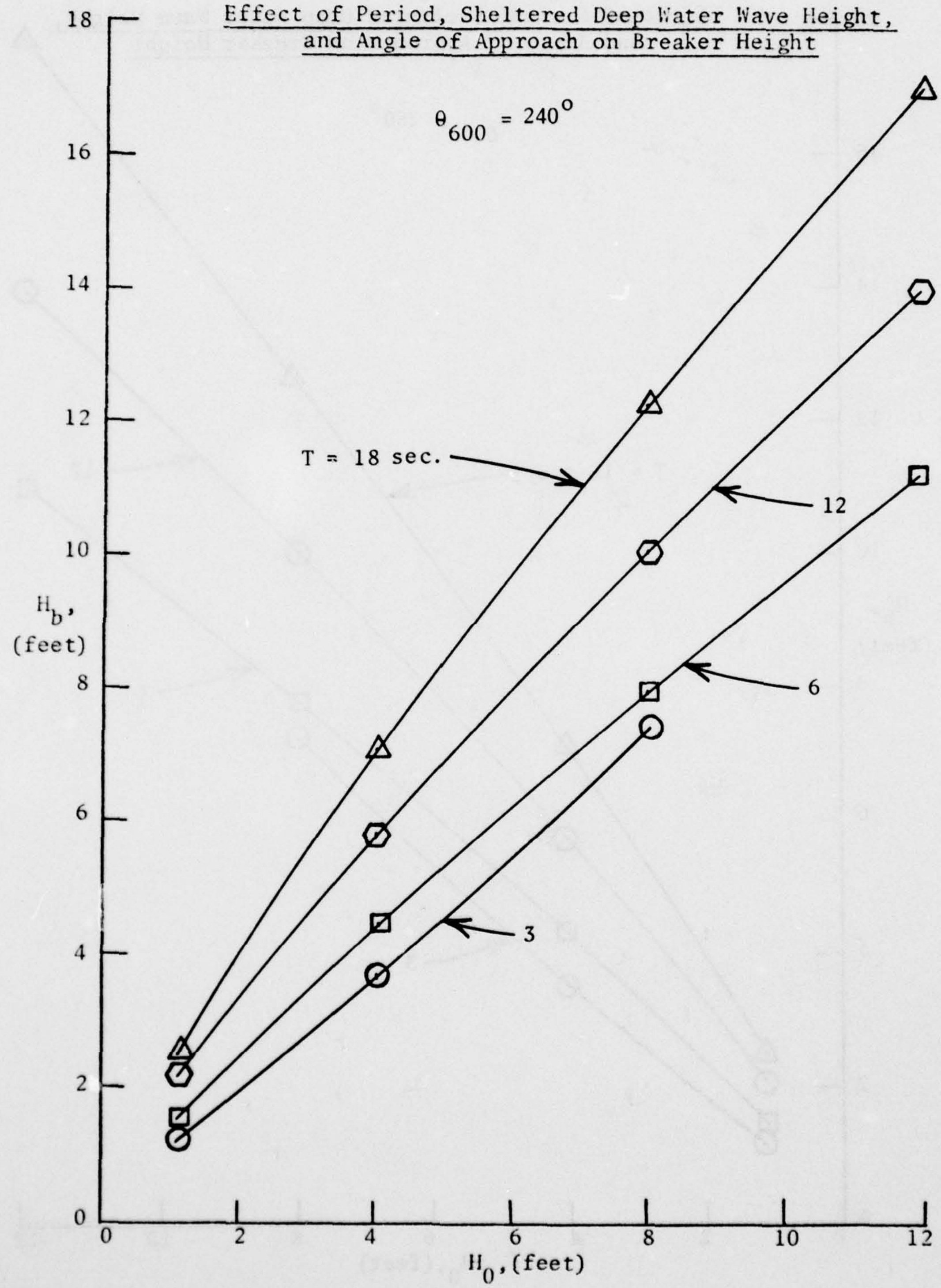
LAS FLORES, CALIFORNIA

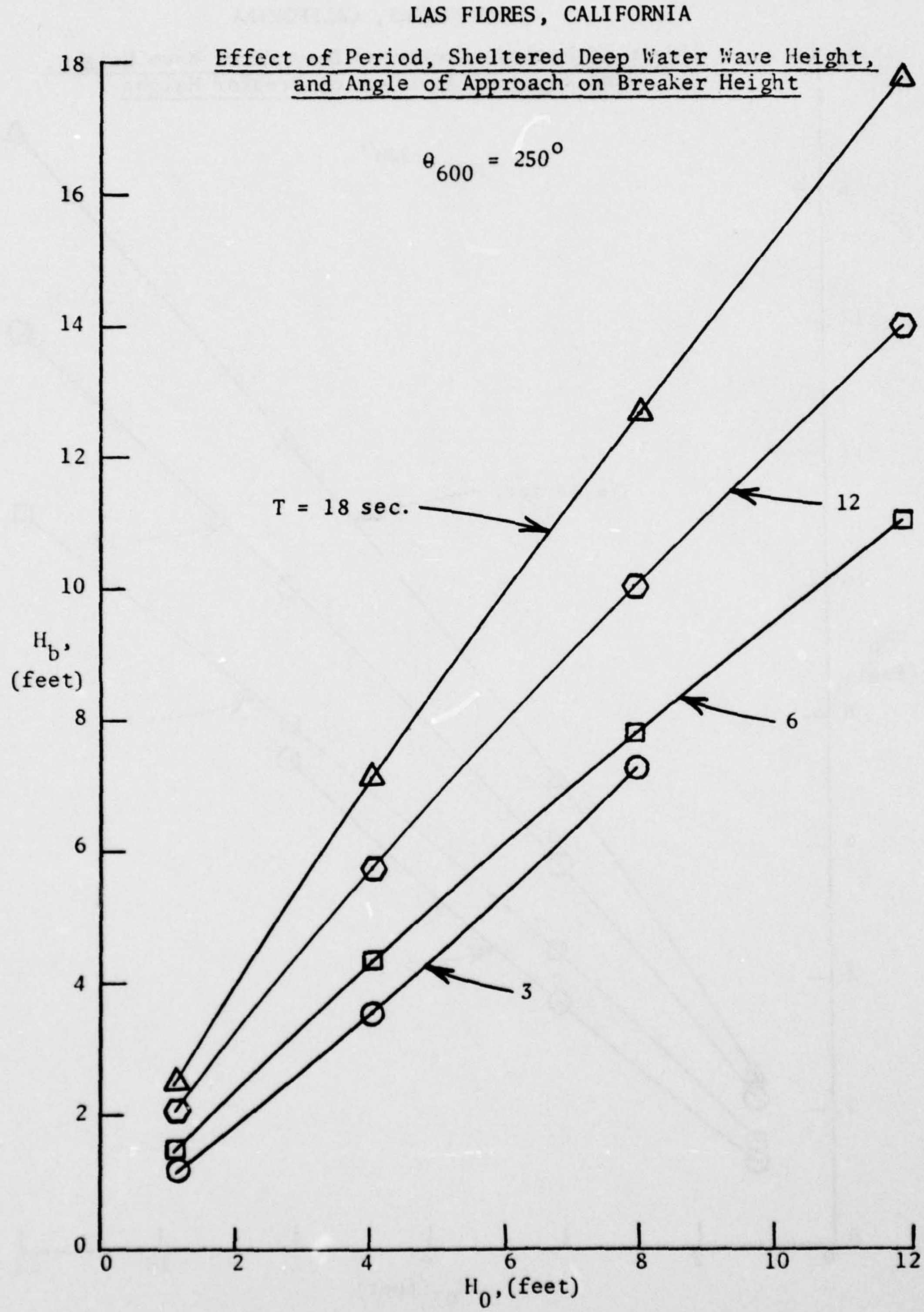
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height



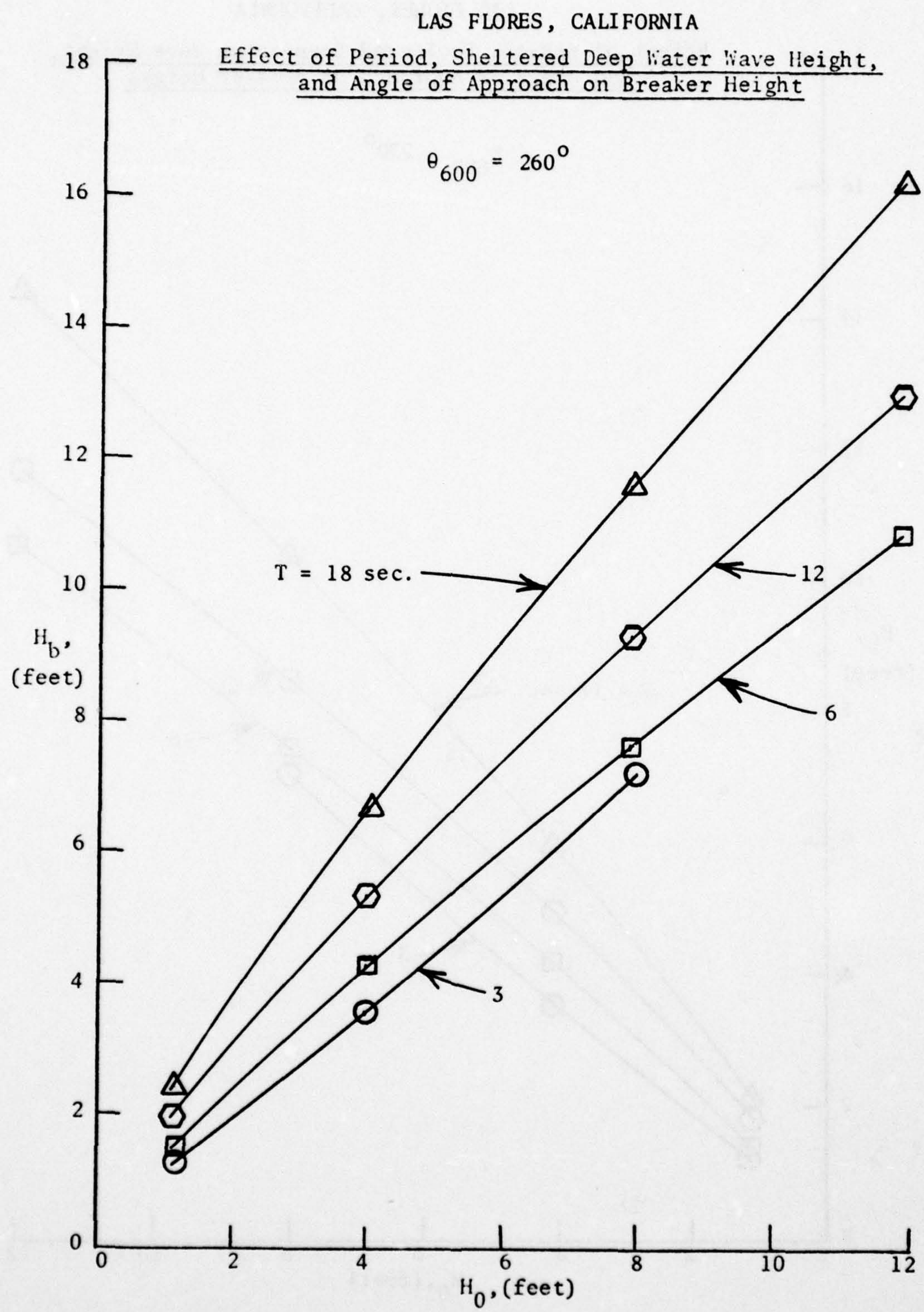
LAS FLORES, CALIFORNIA

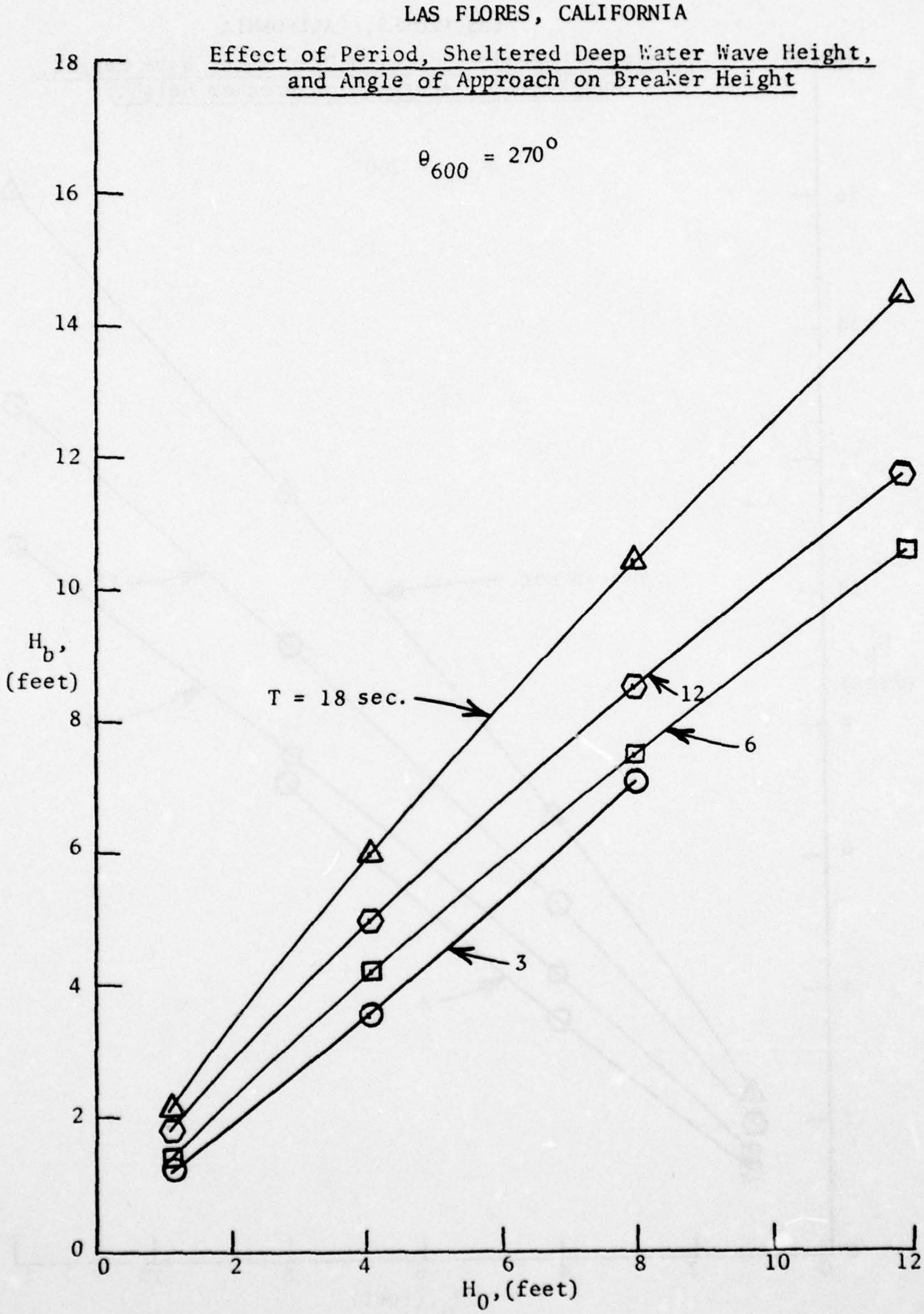
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height





LAS FLORES, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 250^{\circ}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

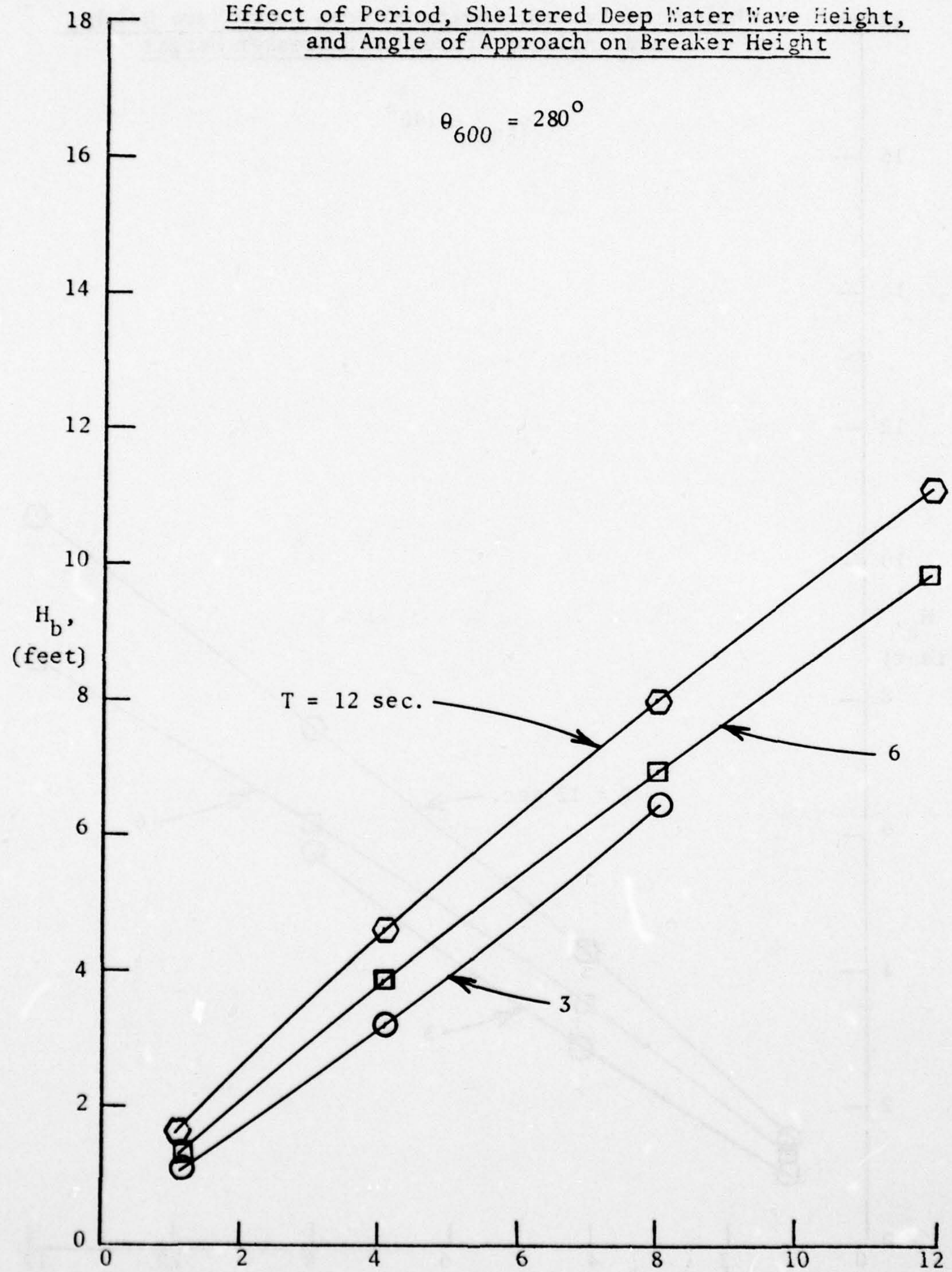

LAS FLORES, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 260^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18


LAS FLORES, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 270^{\circ}$
18
16
14
12
10
8
6
4
2
0
H_b, (feet)
T = 18 sec.
12
6
3
0
2
4
6
8
10
12
H_0,(feet)

LAS FLORES, CALIFORNIA

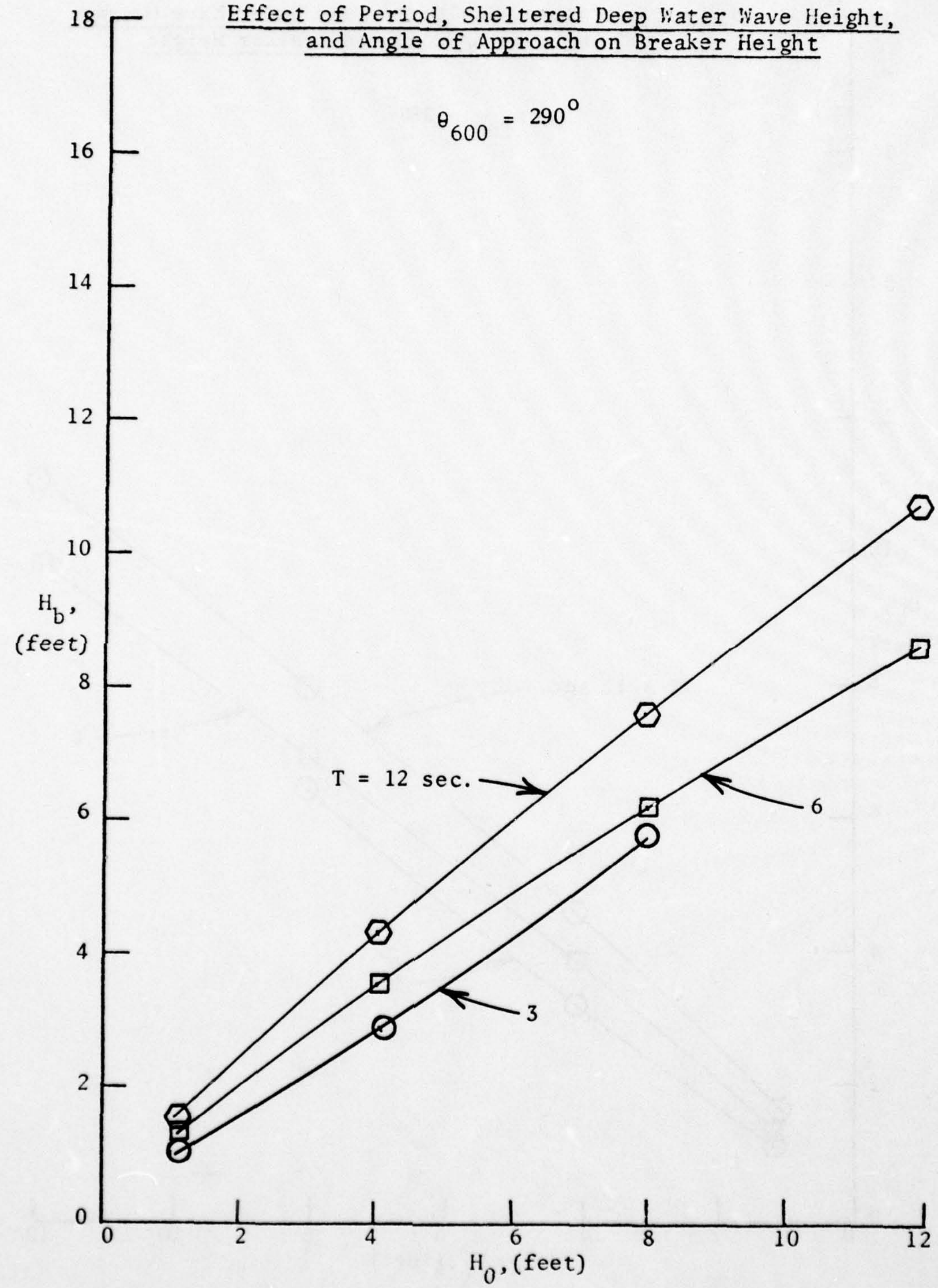
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height

$\theta_{600} = 280^{\circ}$



LAS FLORES, CALIFORNIA

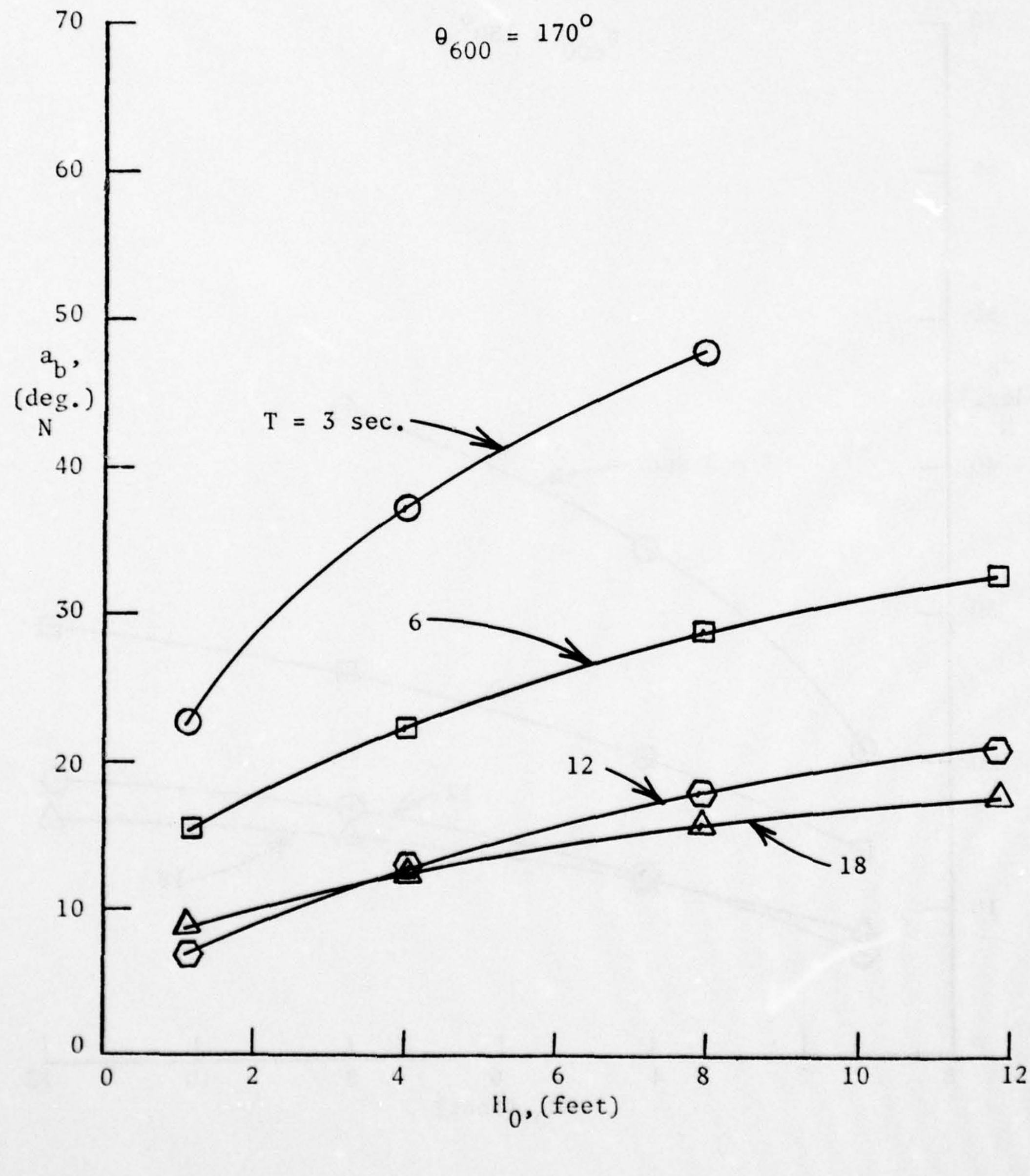
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height



APPENDIX III: EFFECT OF PERIOD, SHELTERED DEEP WATER WAVE HEIGHT, AND ANGLE OF APPROACH ON BREAKER ANGLE, OCEANSIDE, CALIFORNIA

OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



AD-A060 316 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 8/6
COASTAL PROCESSES STUDY OF THE OCEANSIDE, CALIFORNIA, LITTORAL --ETC(U)
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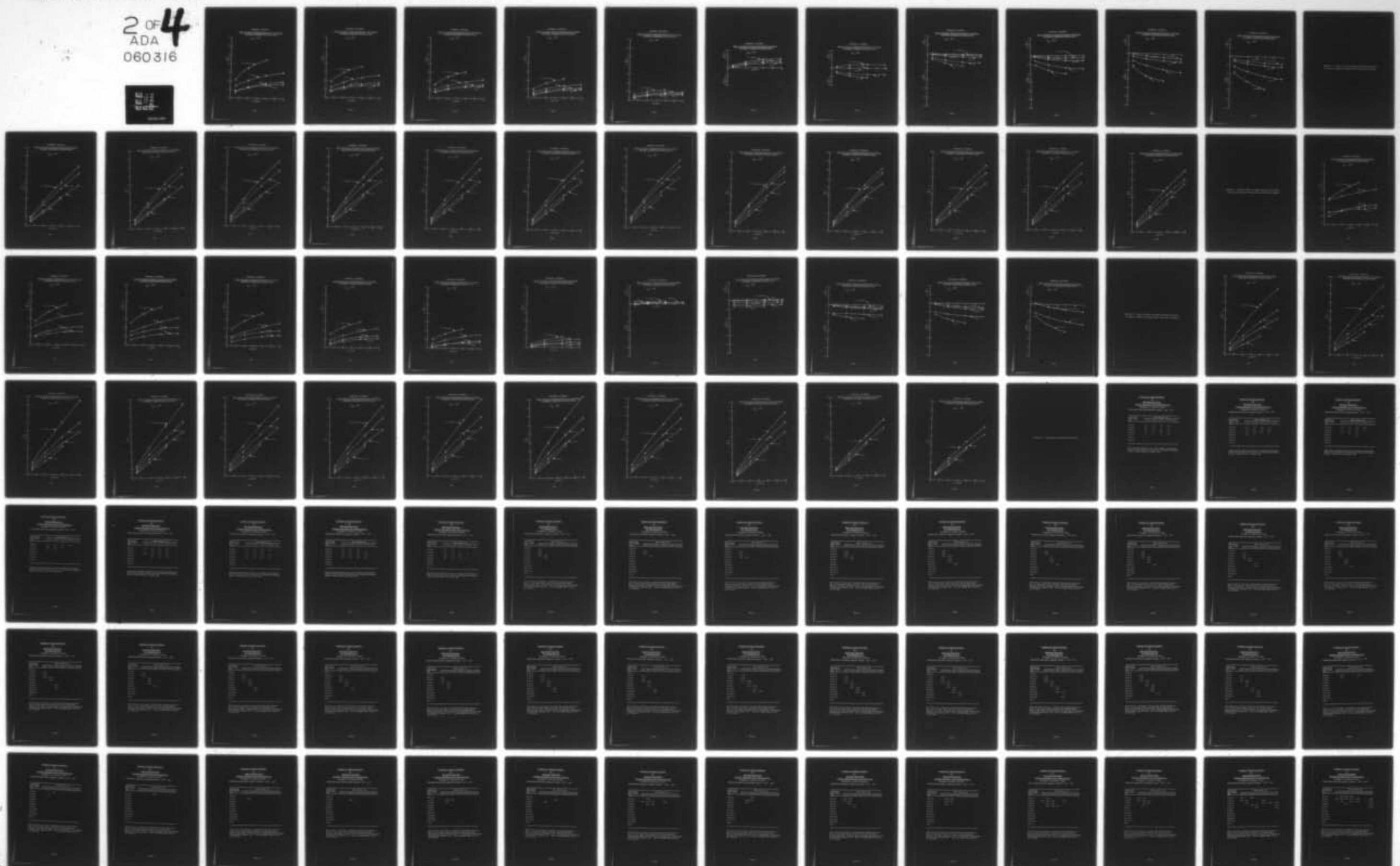
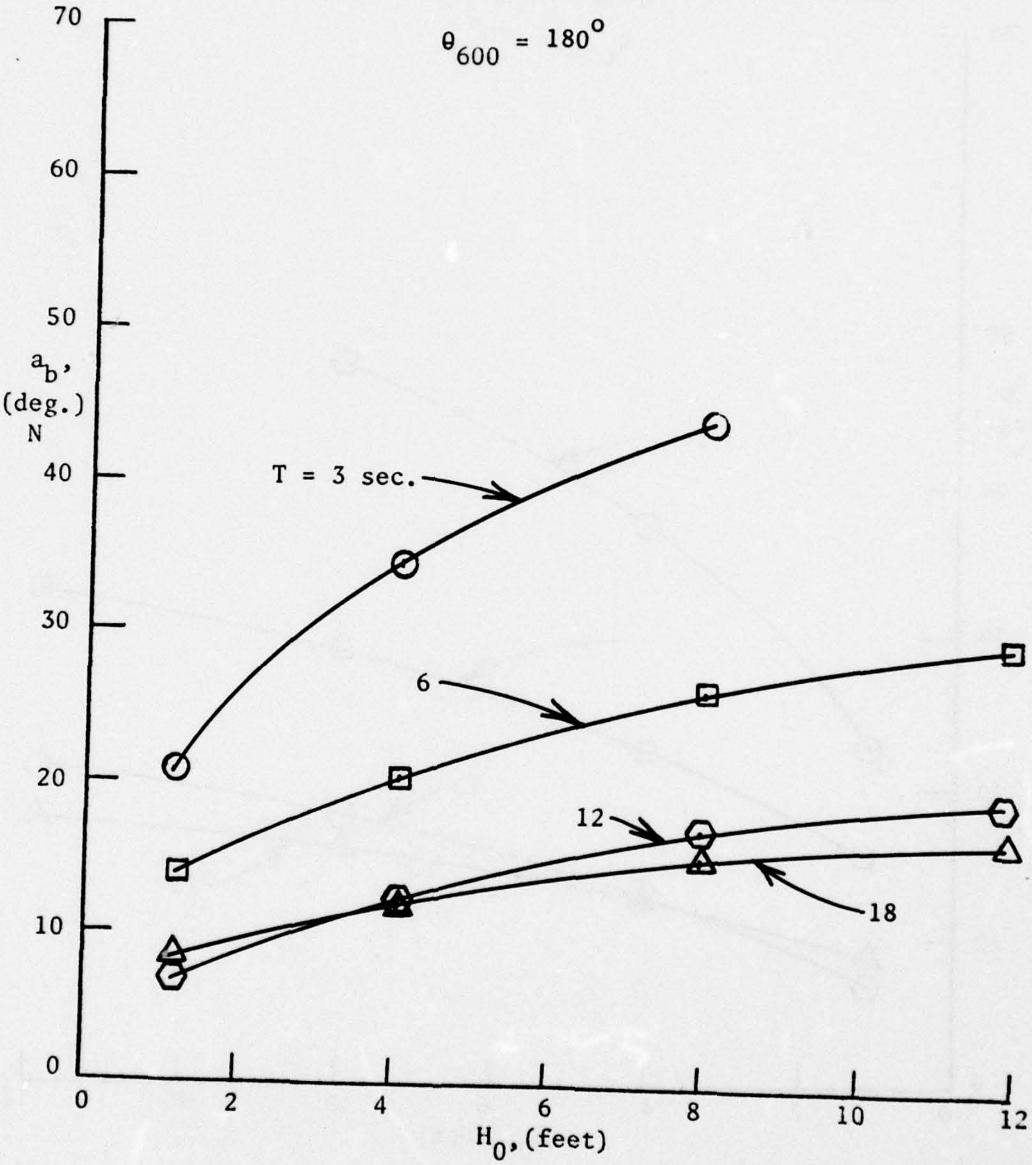


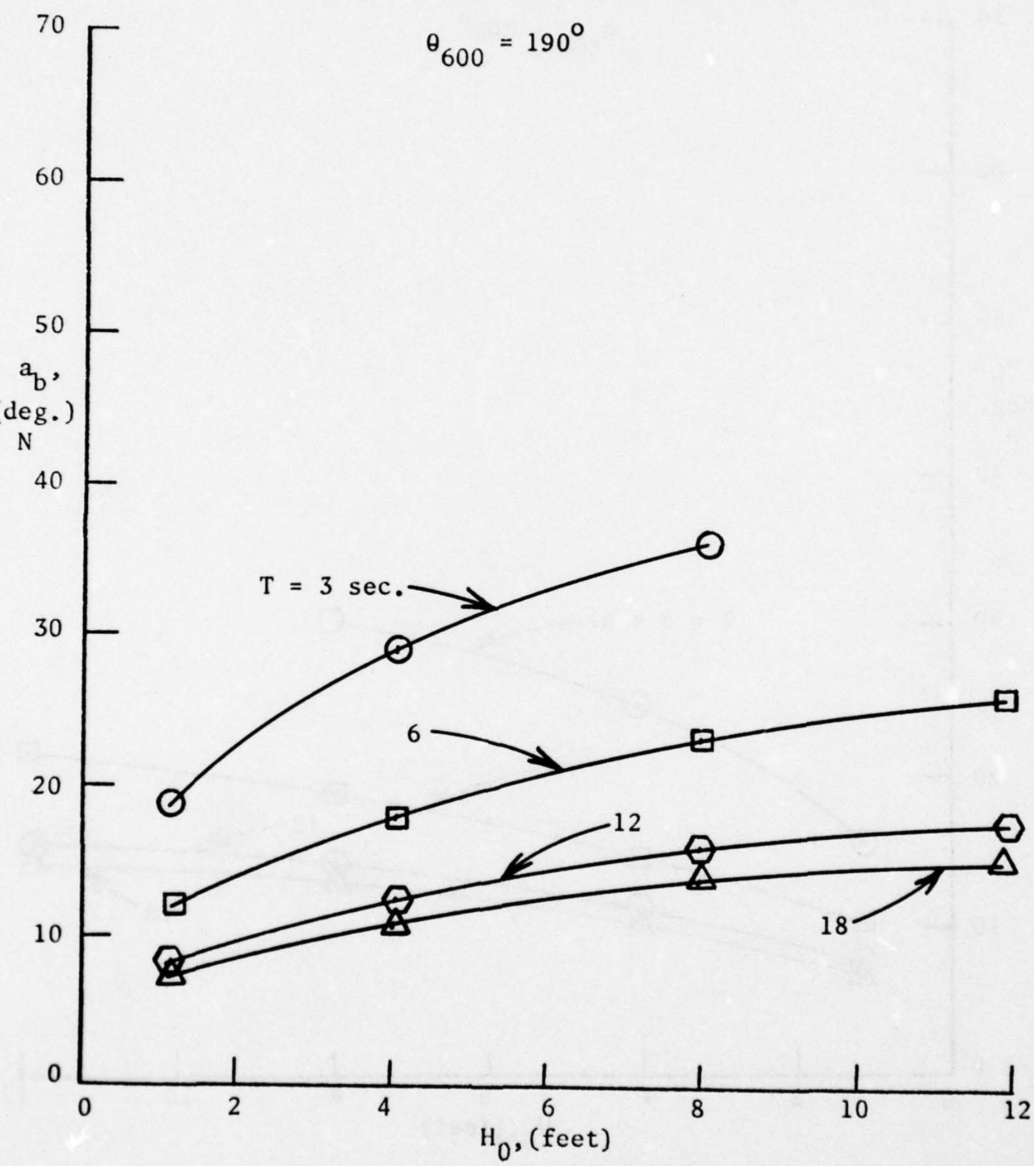
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



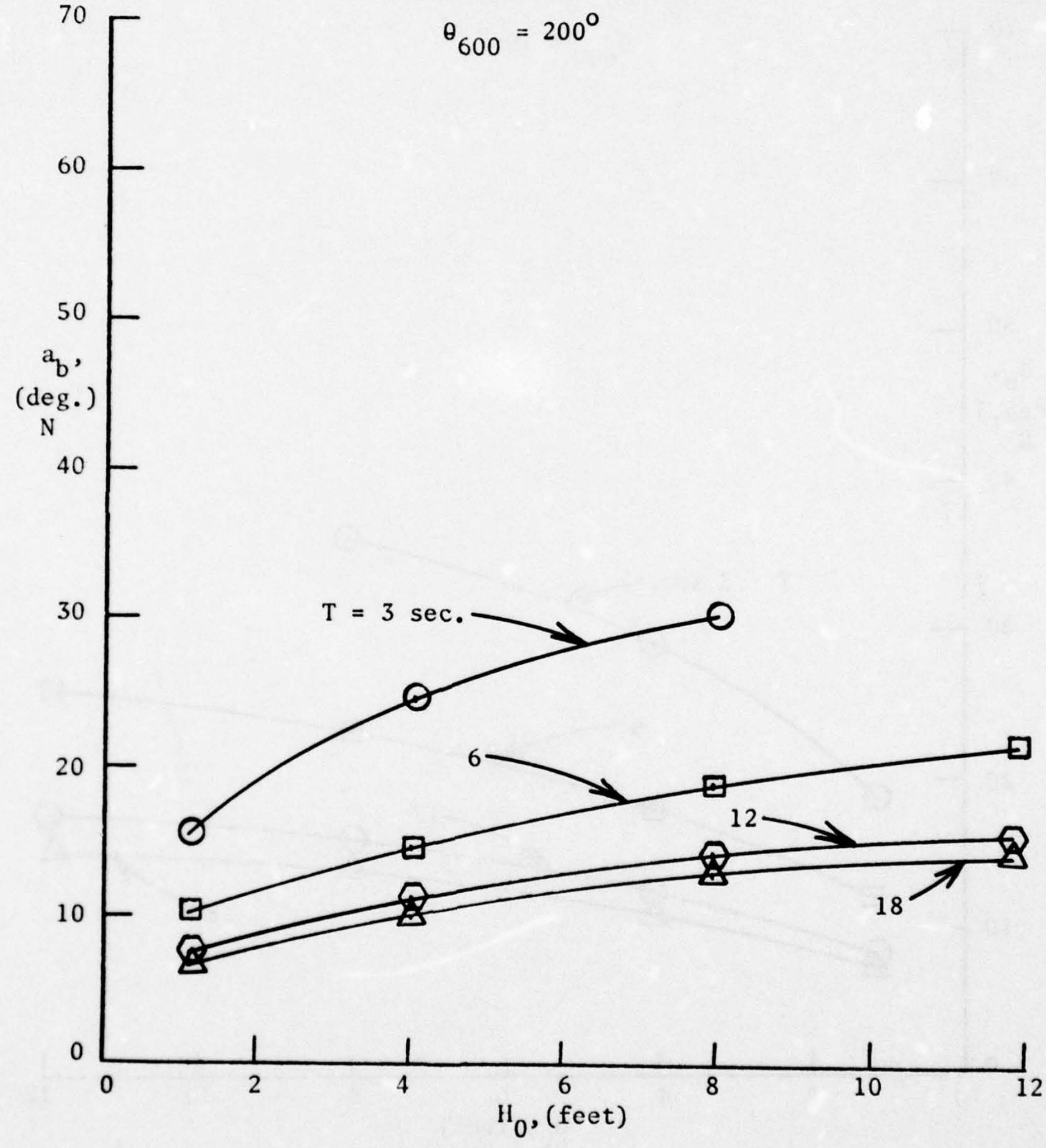
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



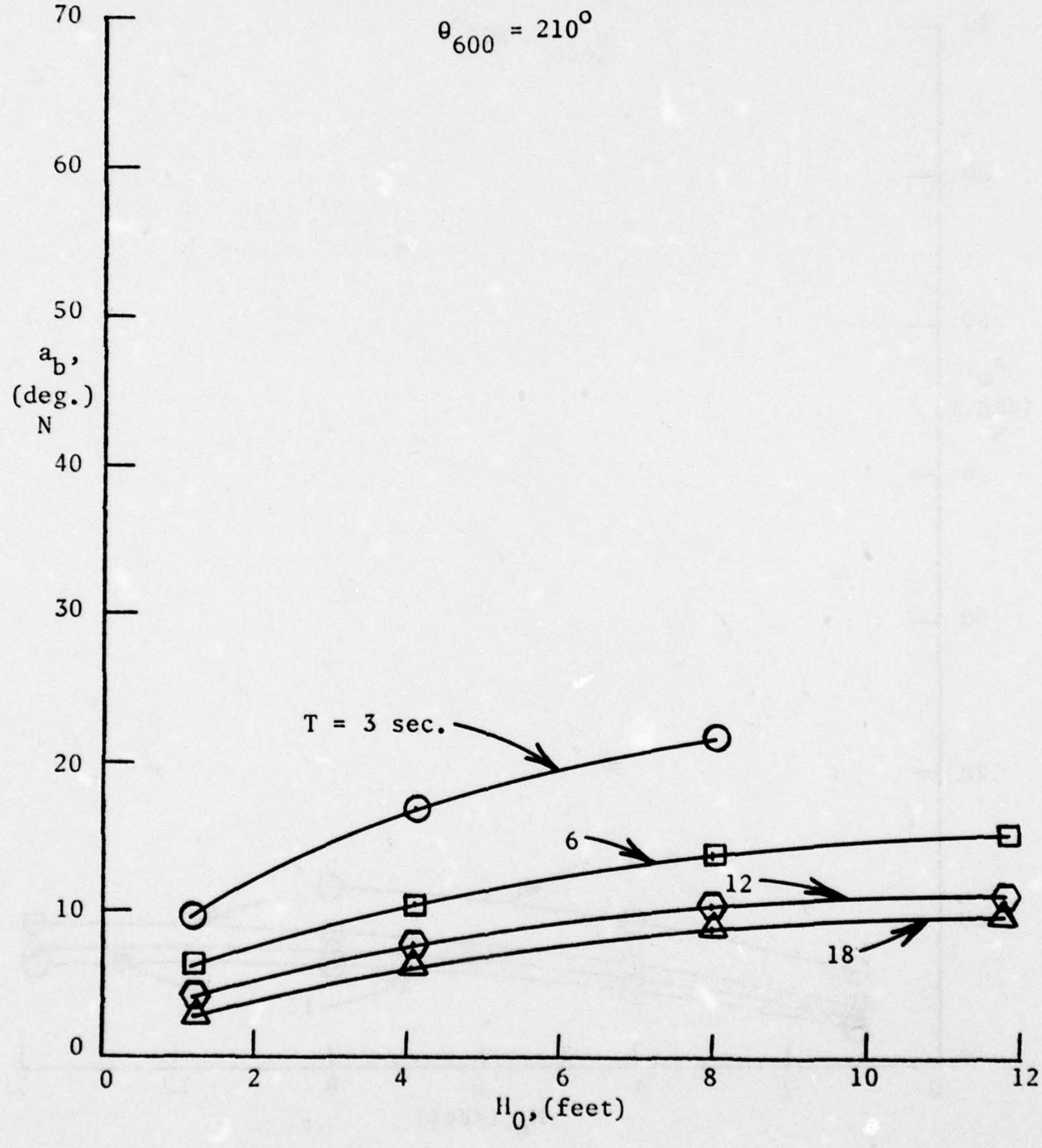
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



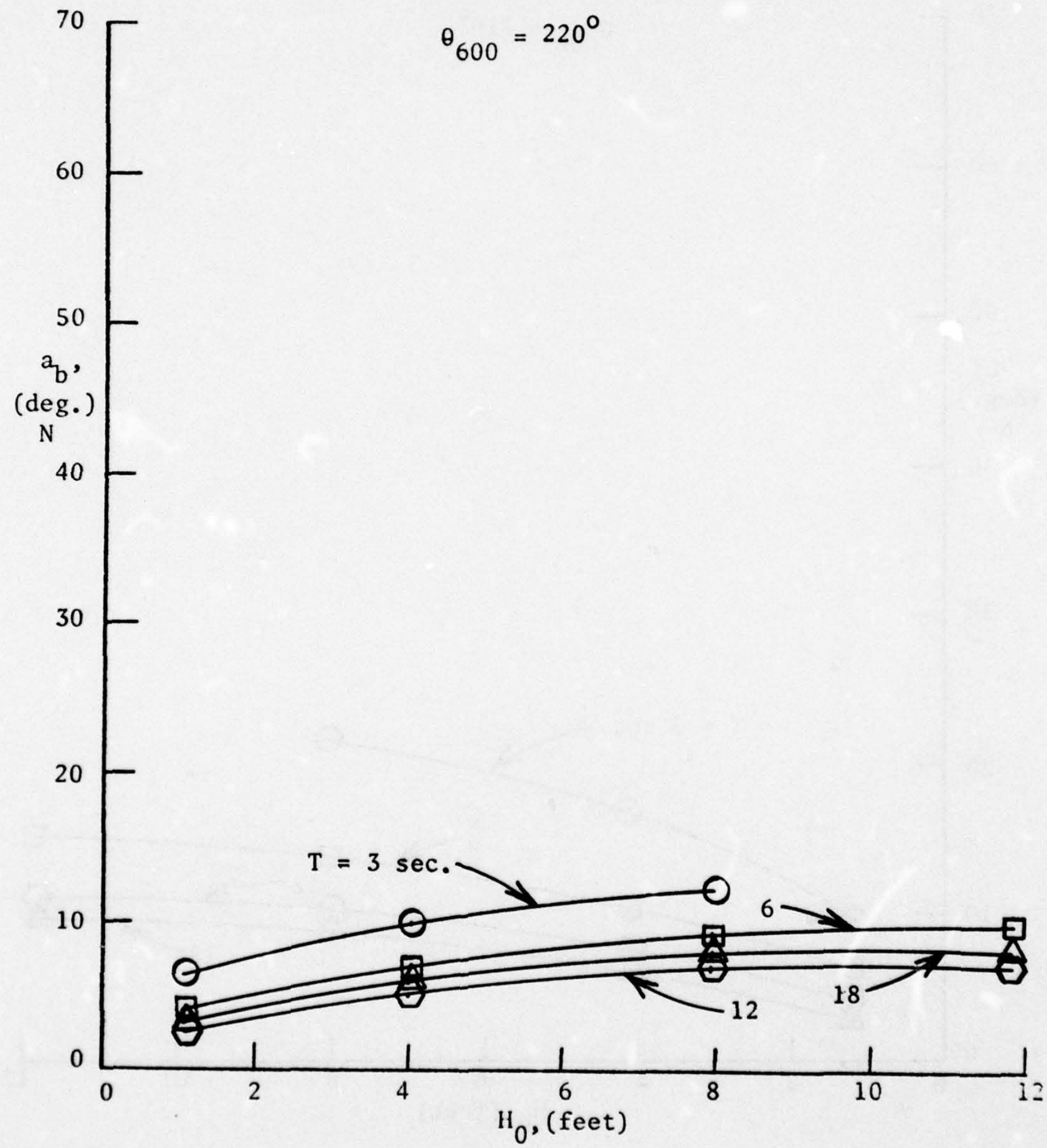
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



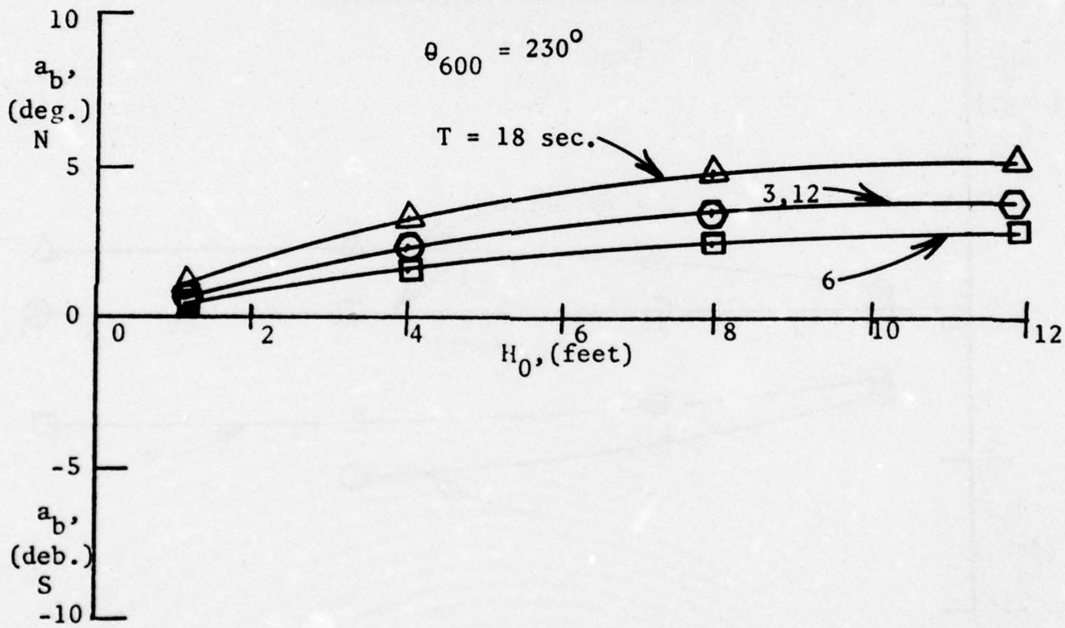
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



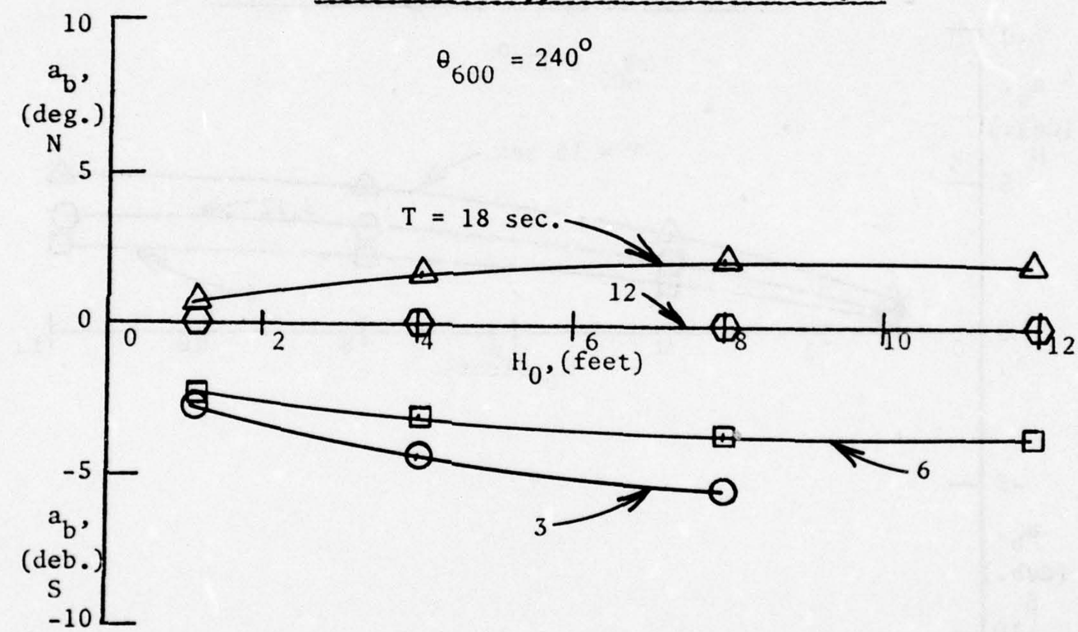
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



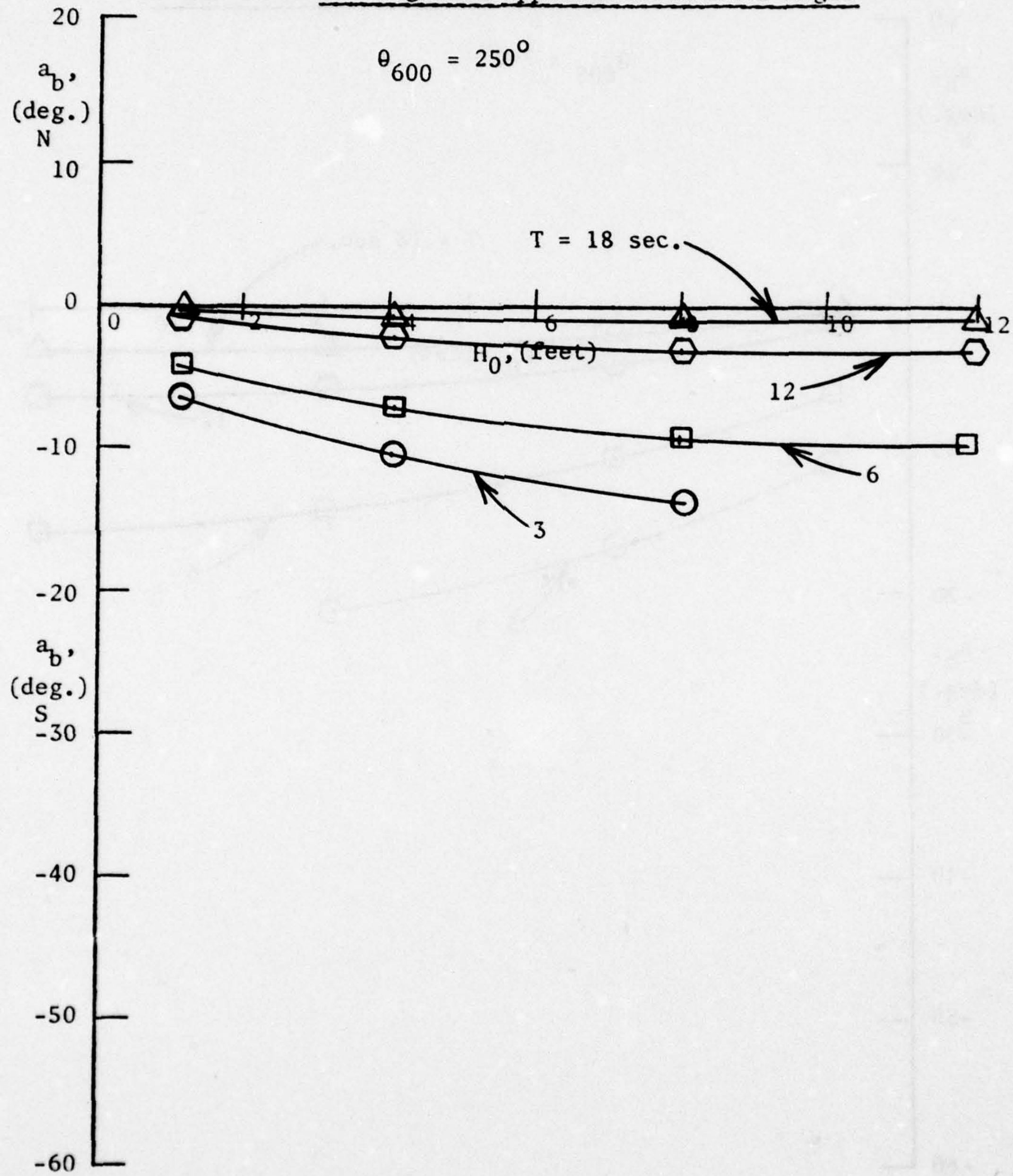
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



OCEANSIDE, CALIFORNIA

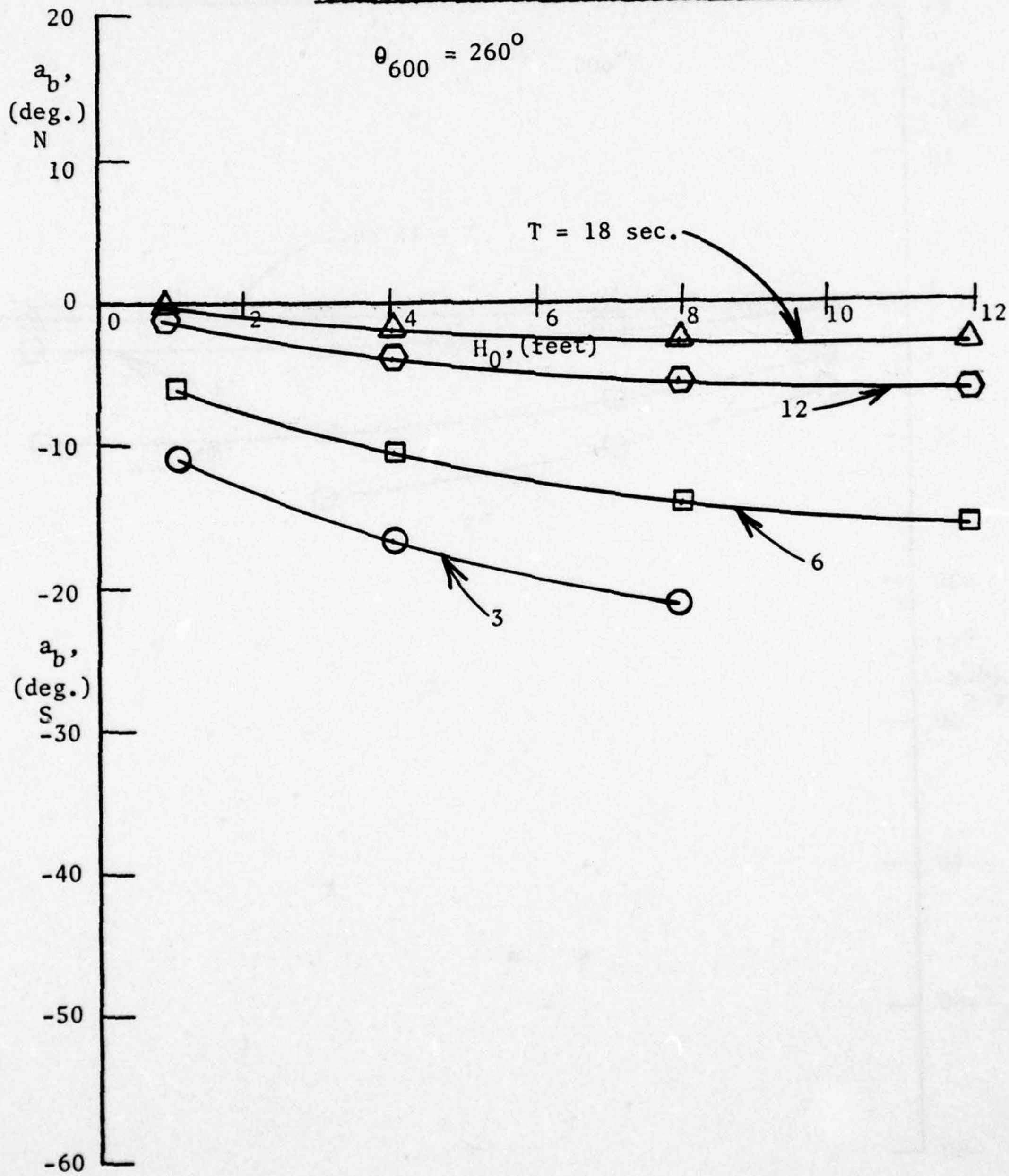
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



100

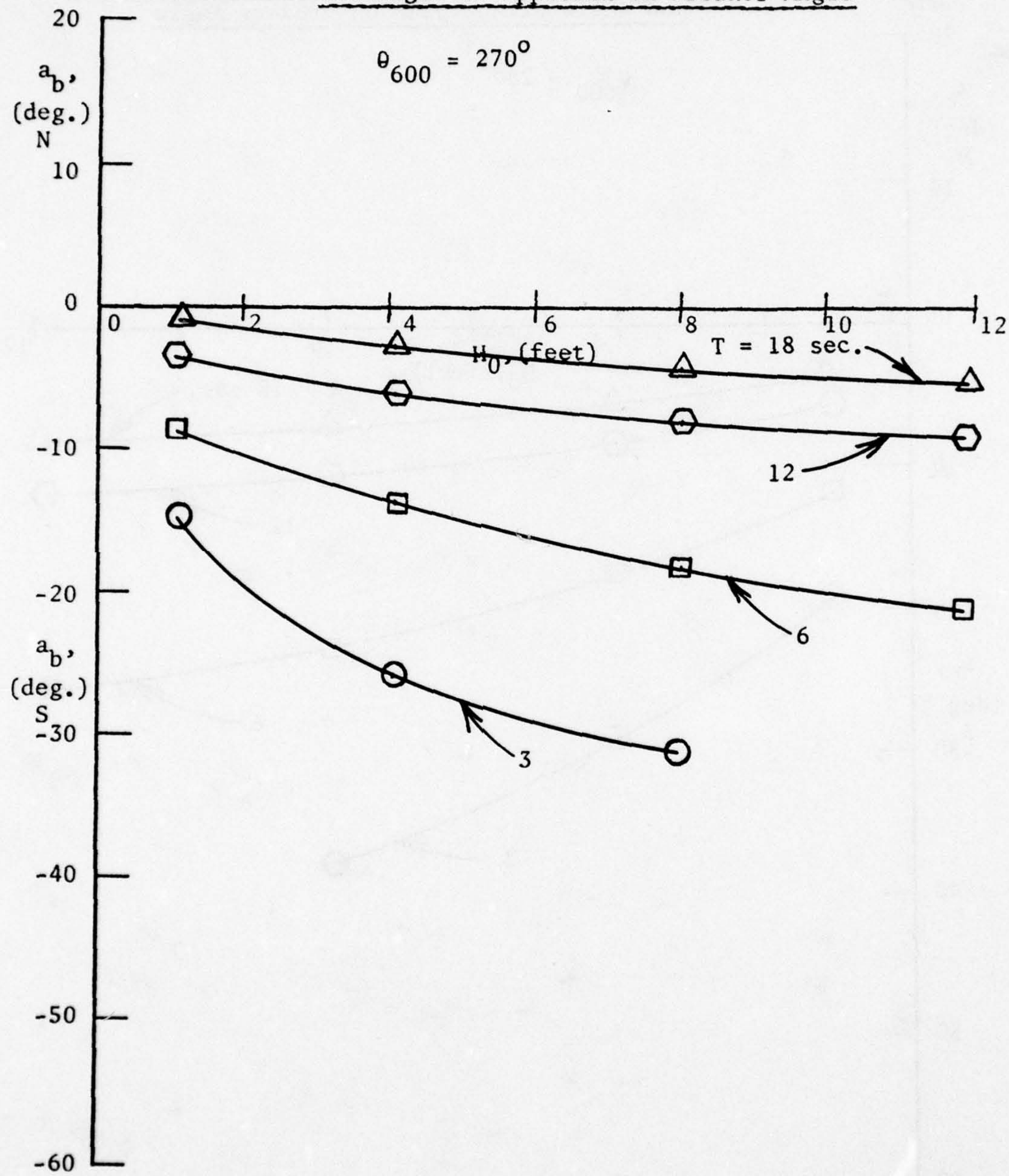
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



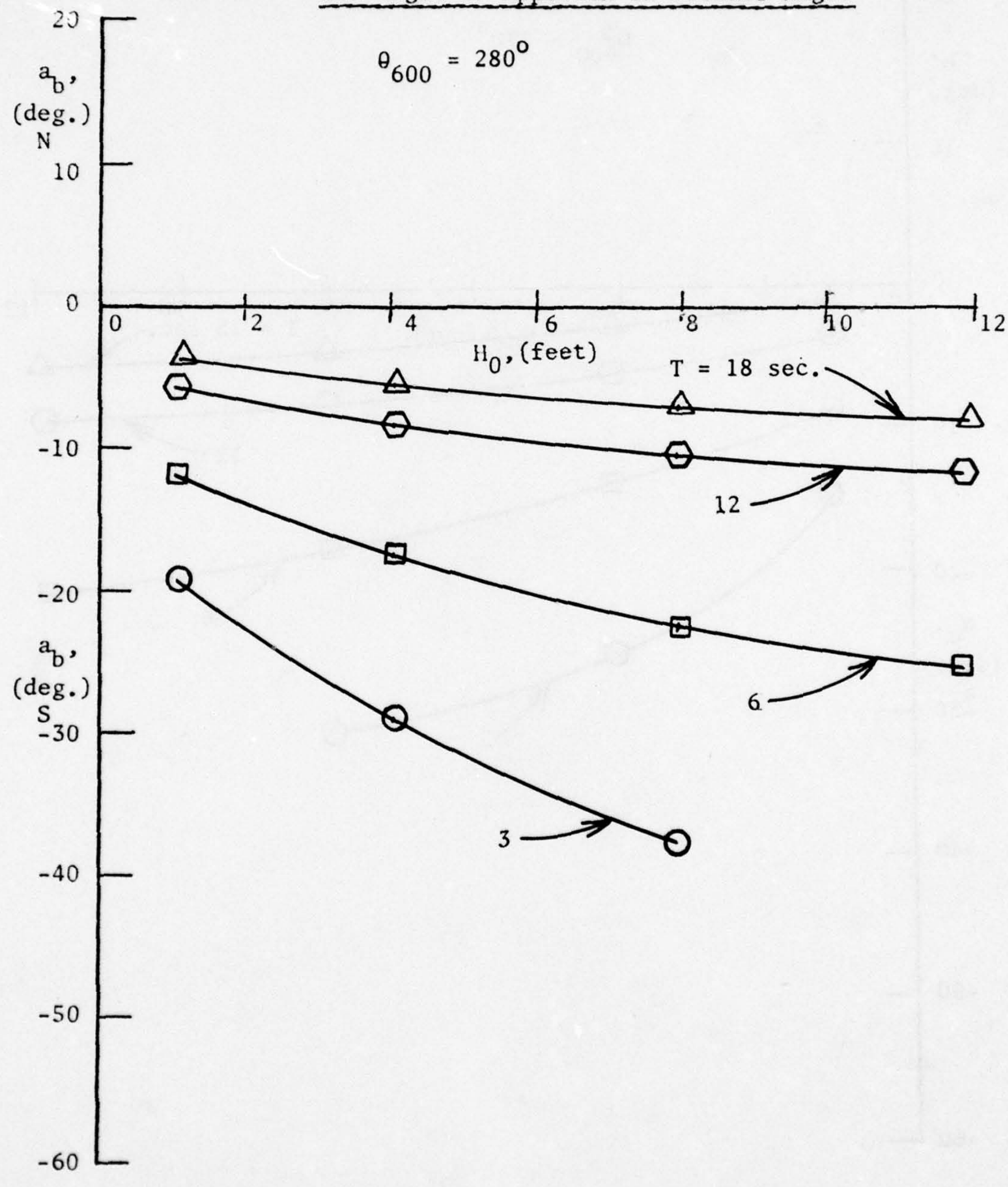
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



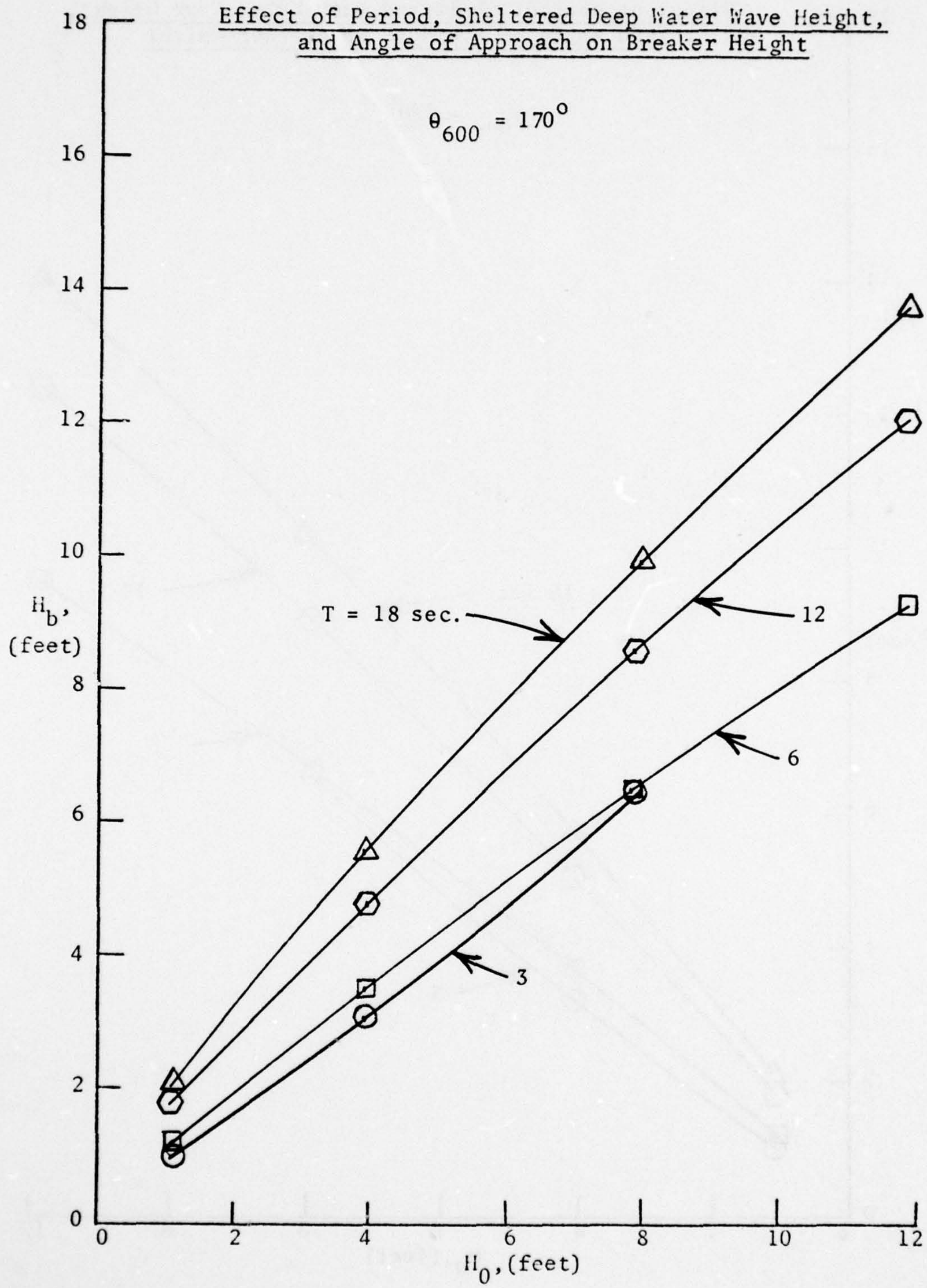
OCEANSIDE, CALIFORNIA

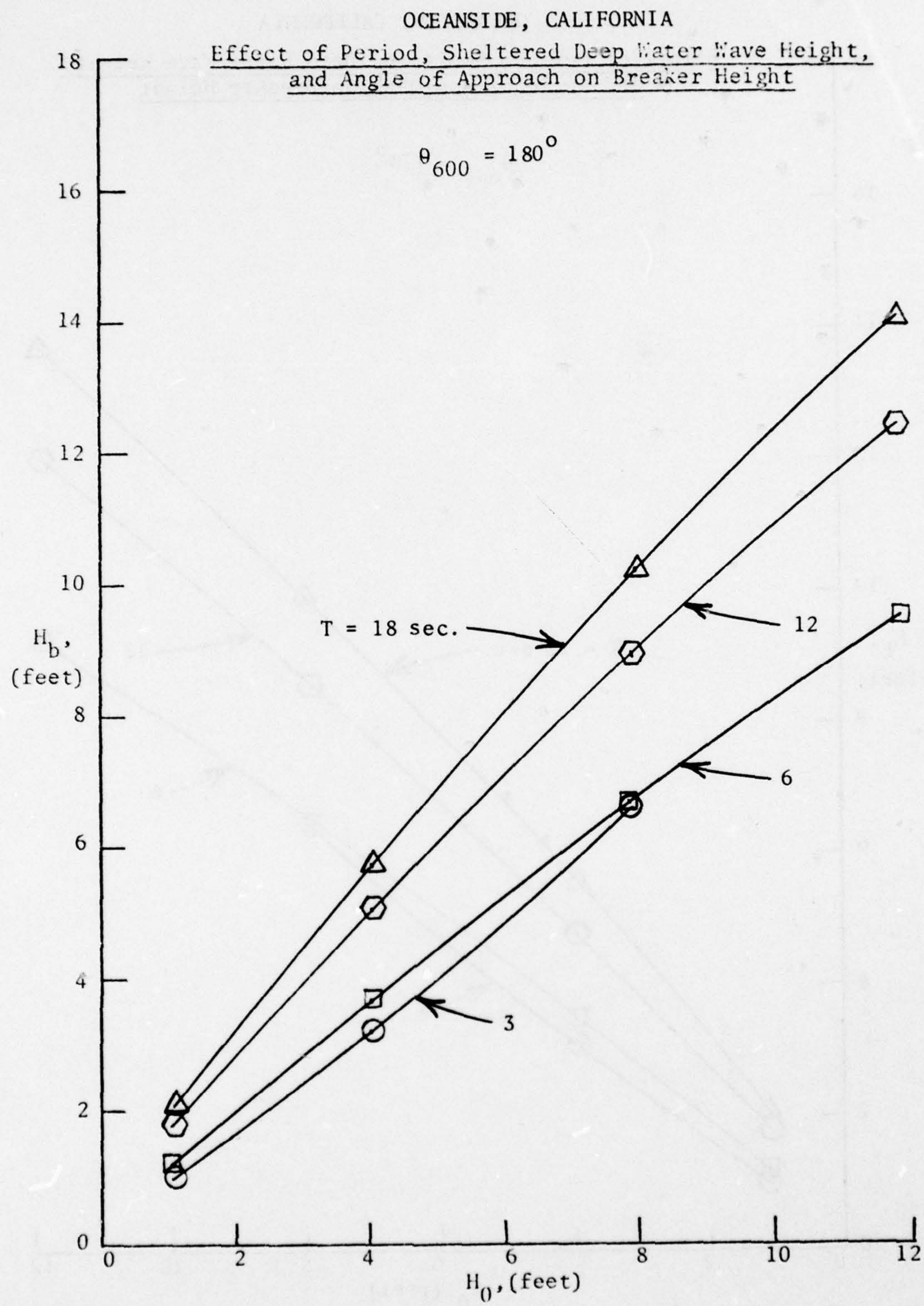
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



APPENDIX IV: EFFECT OF PERIOD, SHELTERED DEEP WATER WAVE HEIGHT, AND ANGLE OF APPROACH ON BREAKER HEIGHT, OCEANSIDE, CALIFORNIA

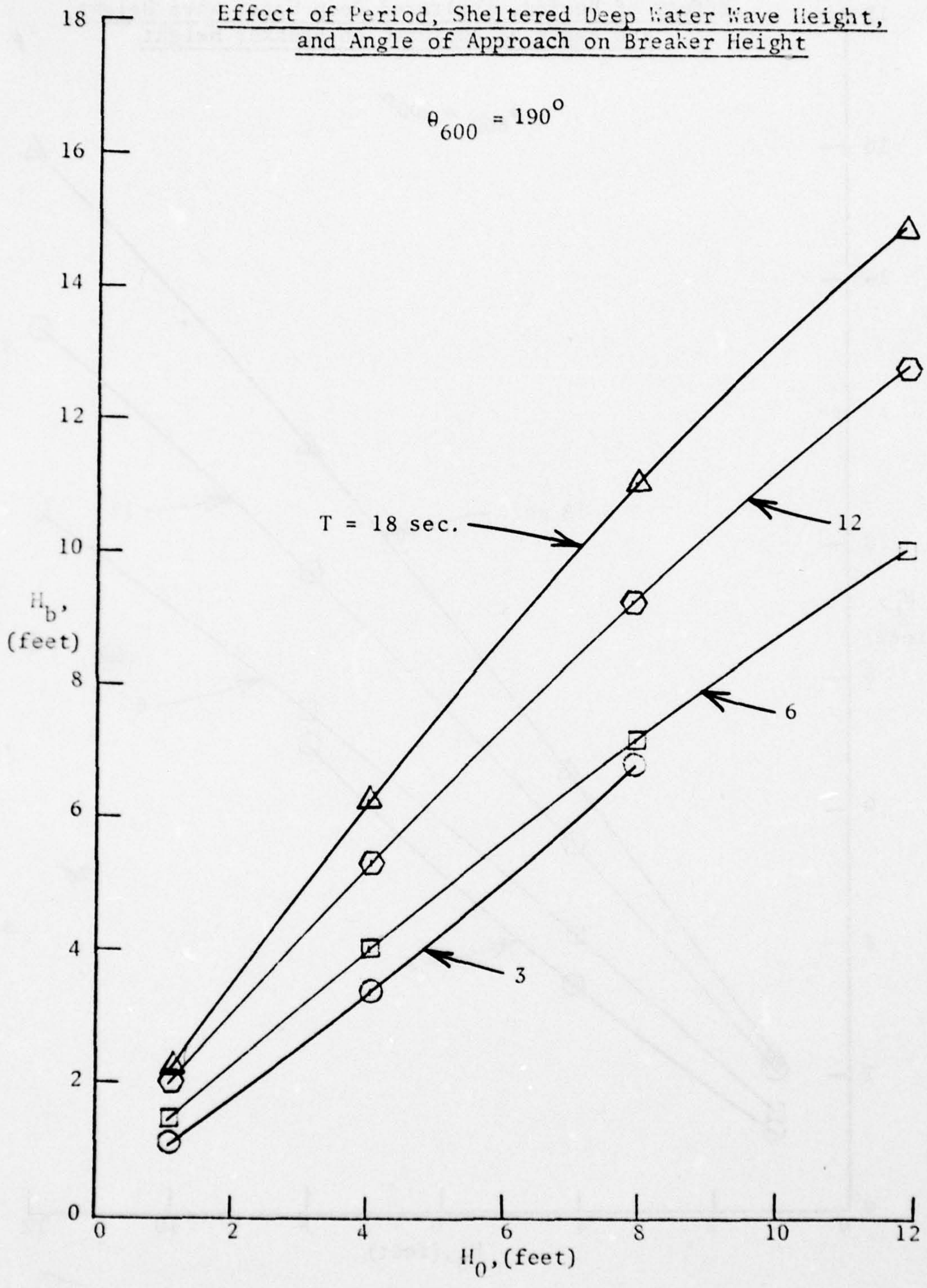
OCEANSIDE, CALIFORNIA

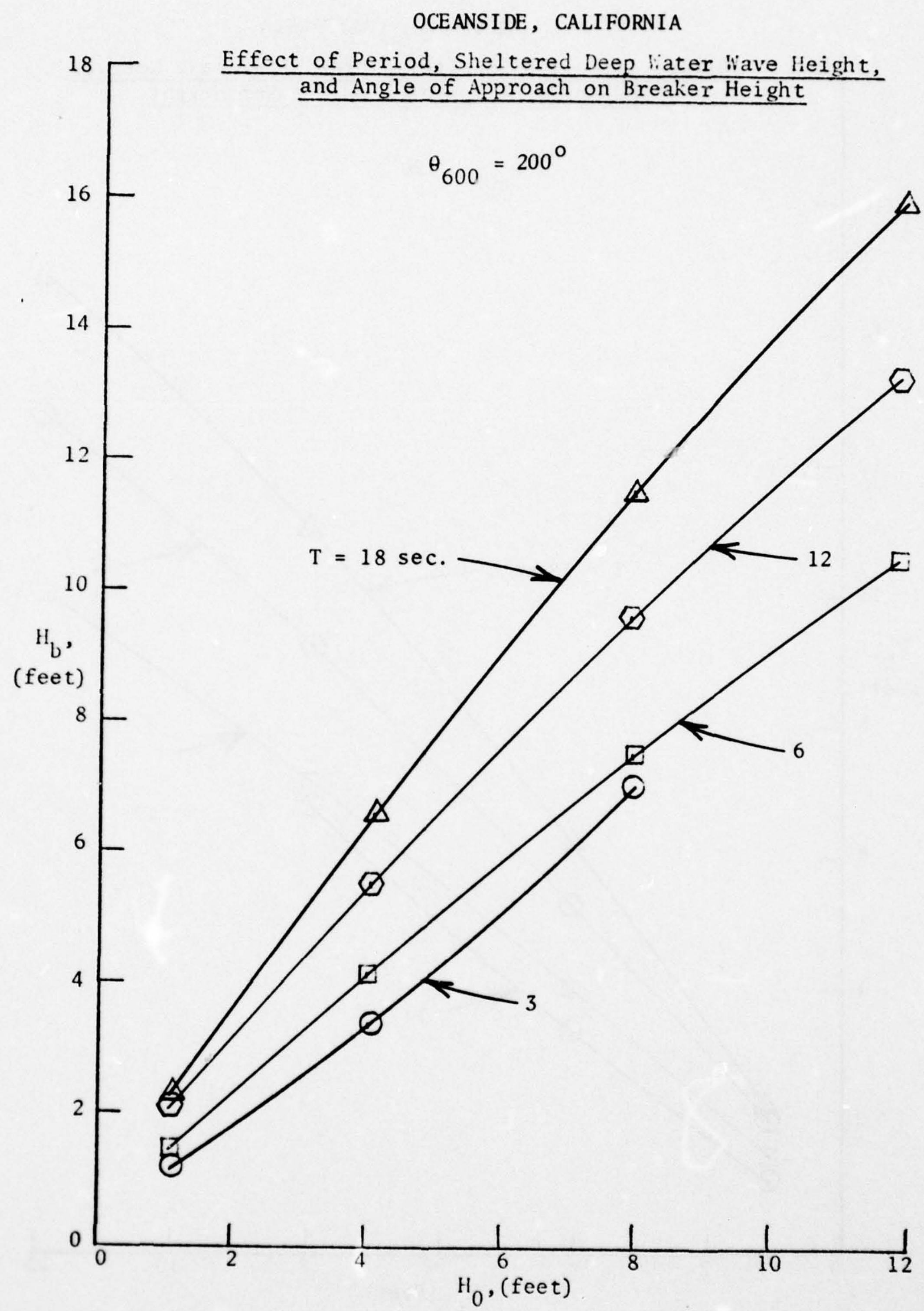



OCEANSIDE, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 180^{\circ}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height

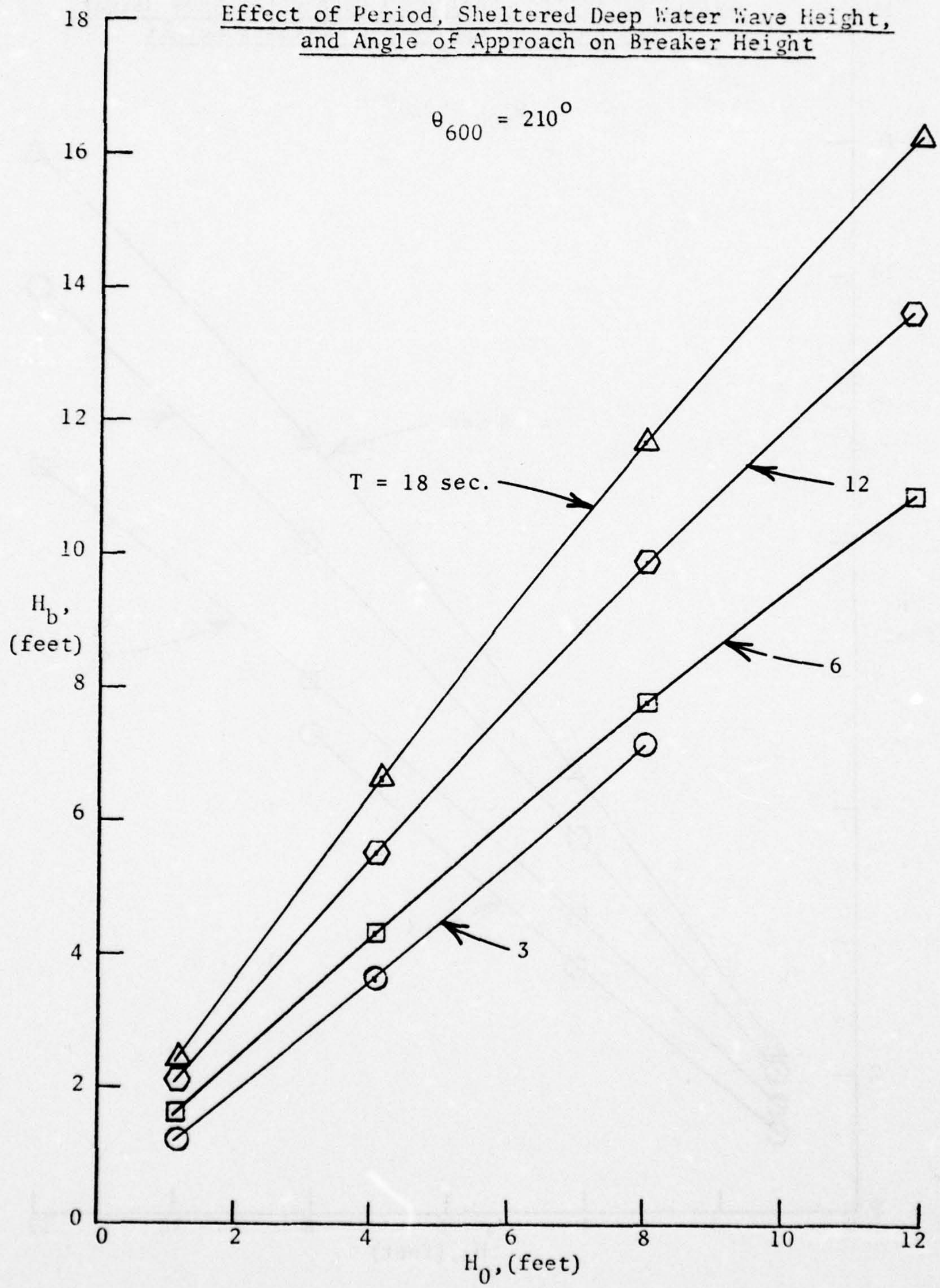




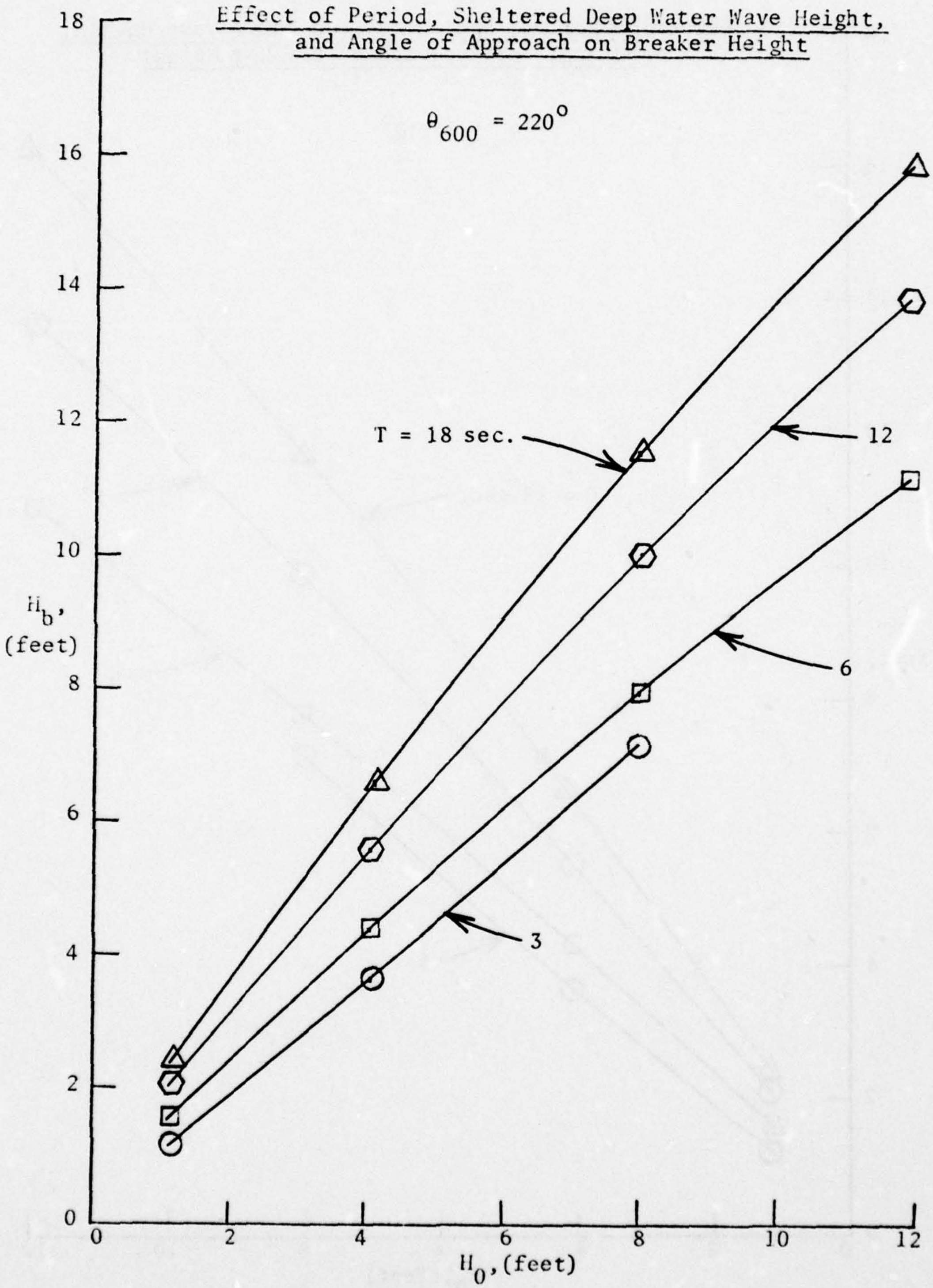
OCEANSIDE, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 200^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height



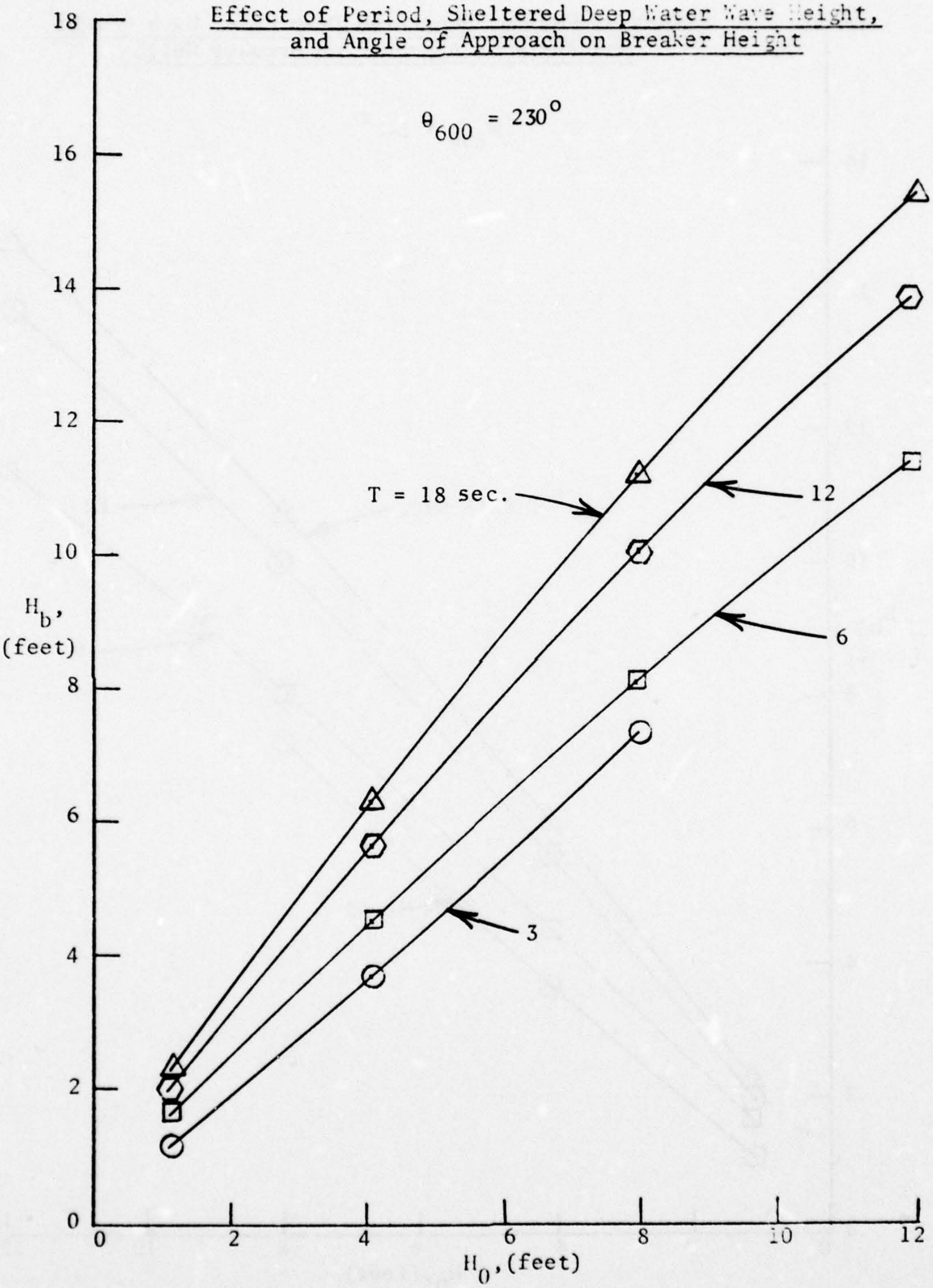
OCEANSIDE, CALIFORNIA

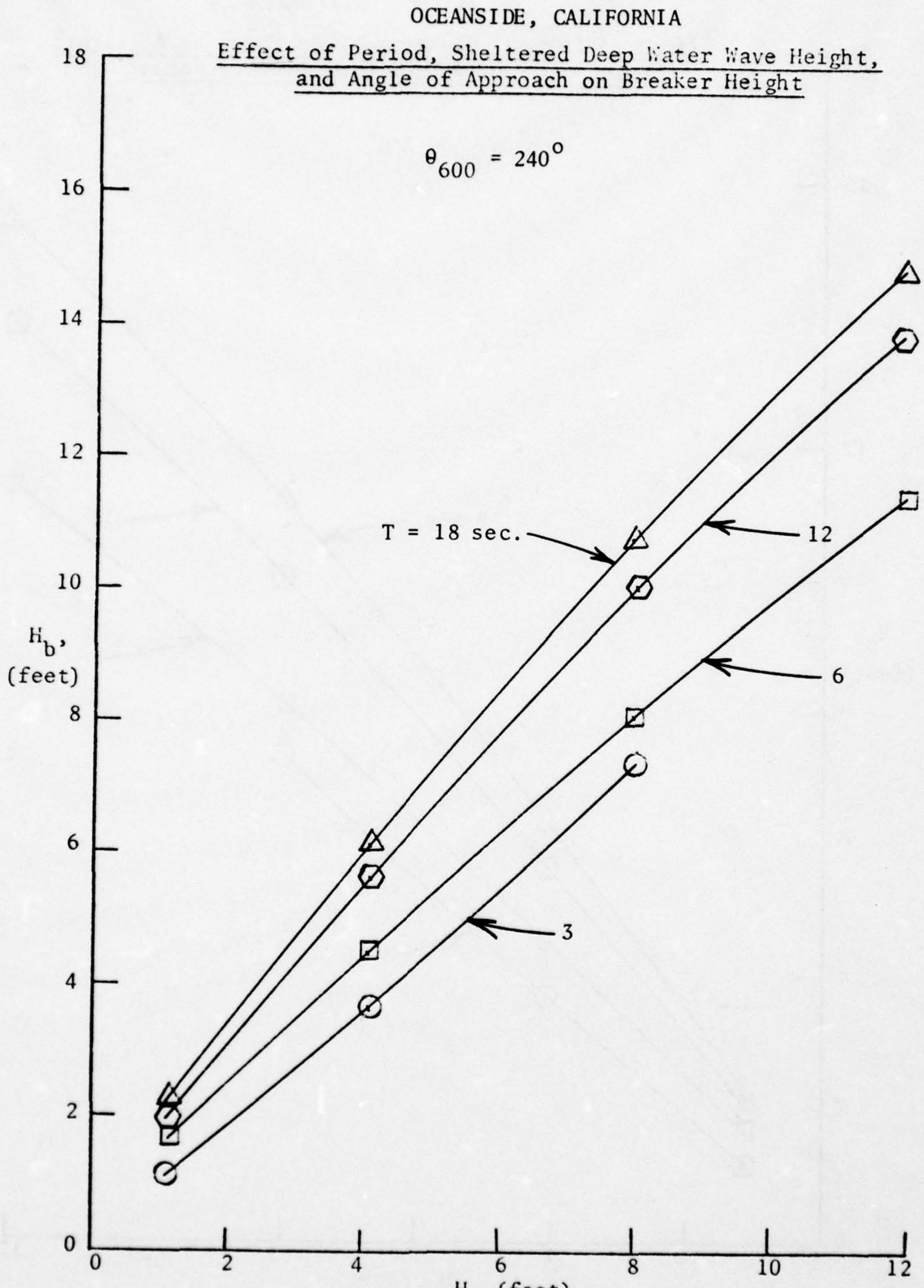


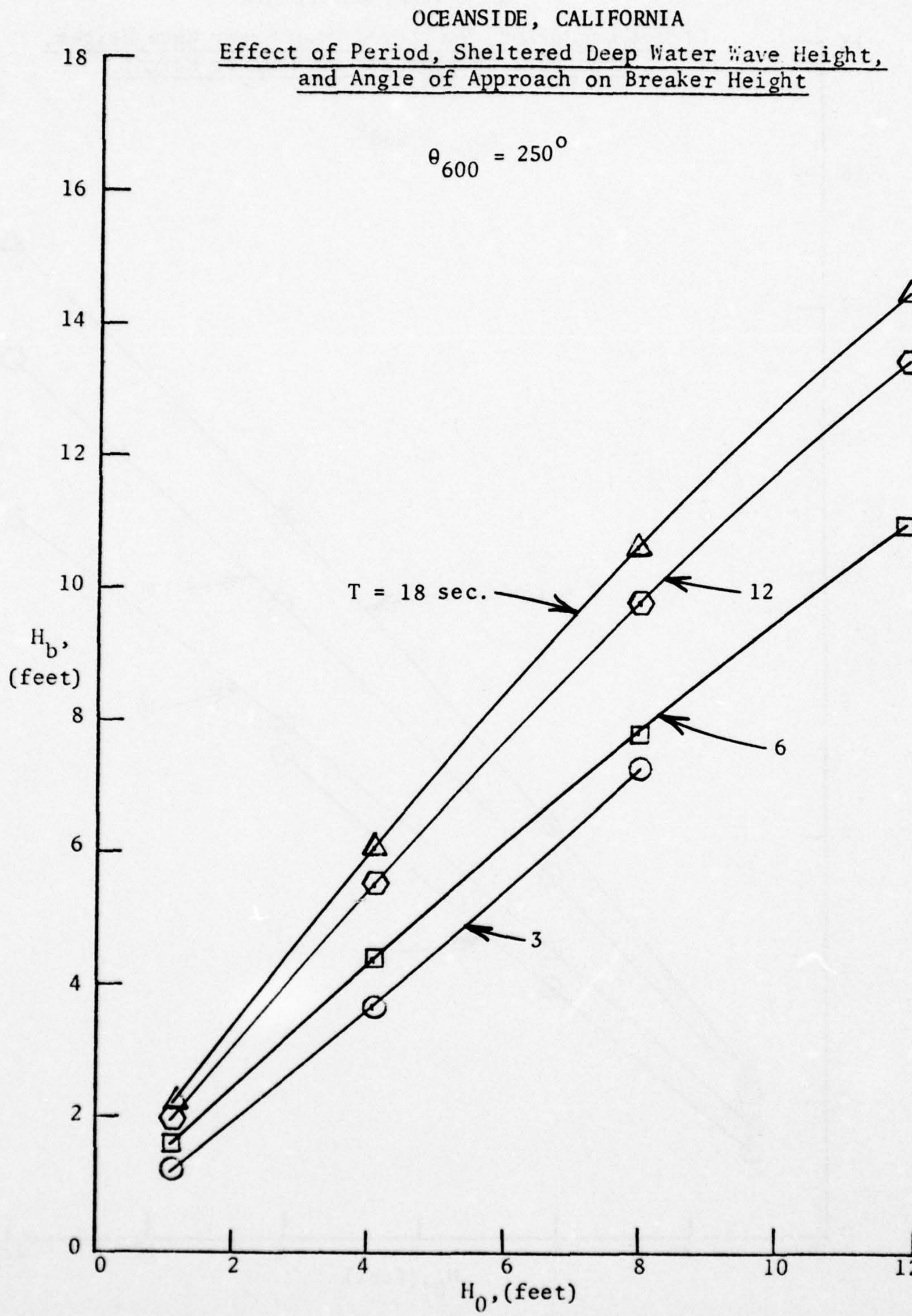
OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height

$\theta_{600} = 230^{\circ}$



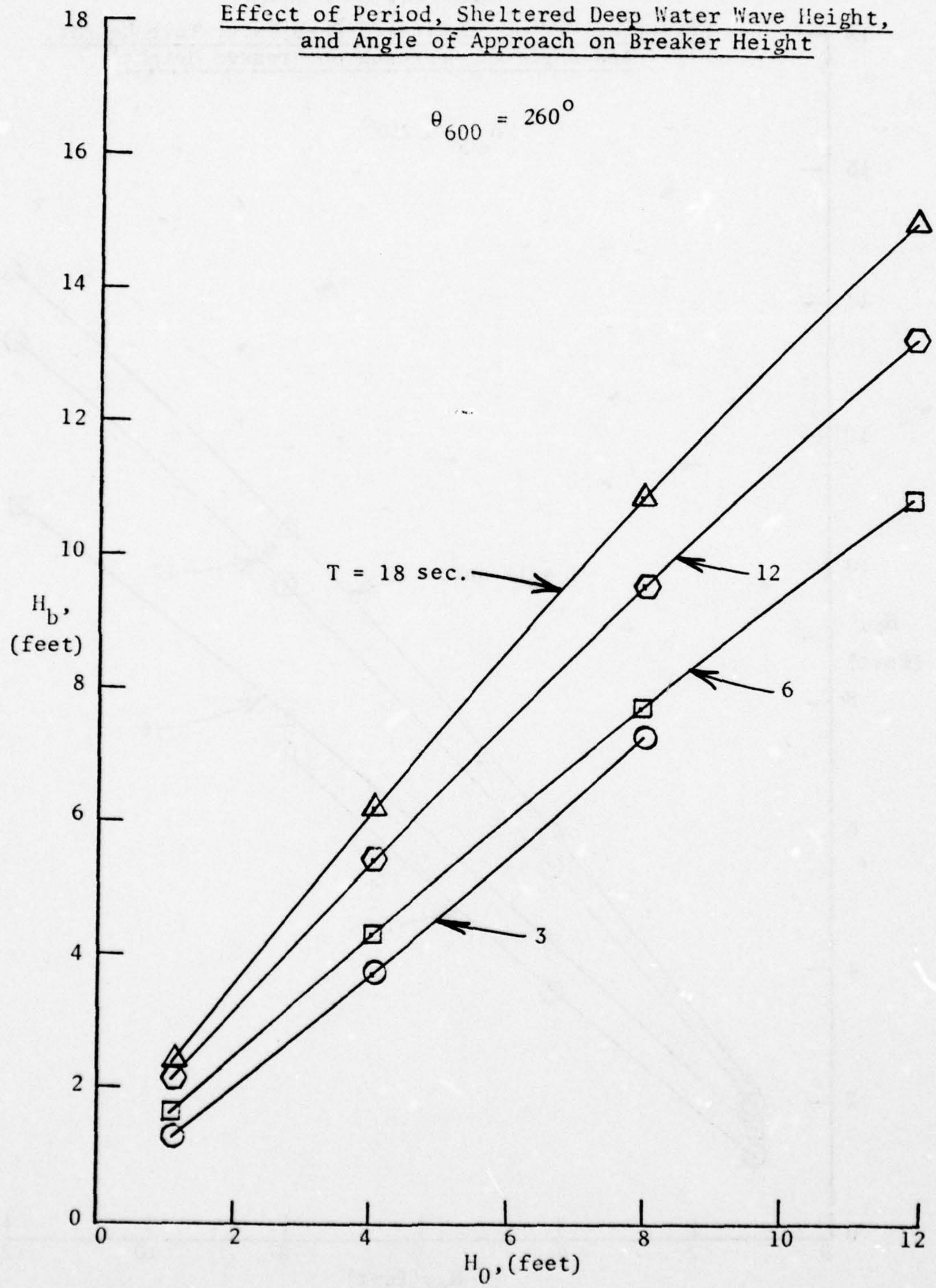

OCEANSIDE, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 240^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

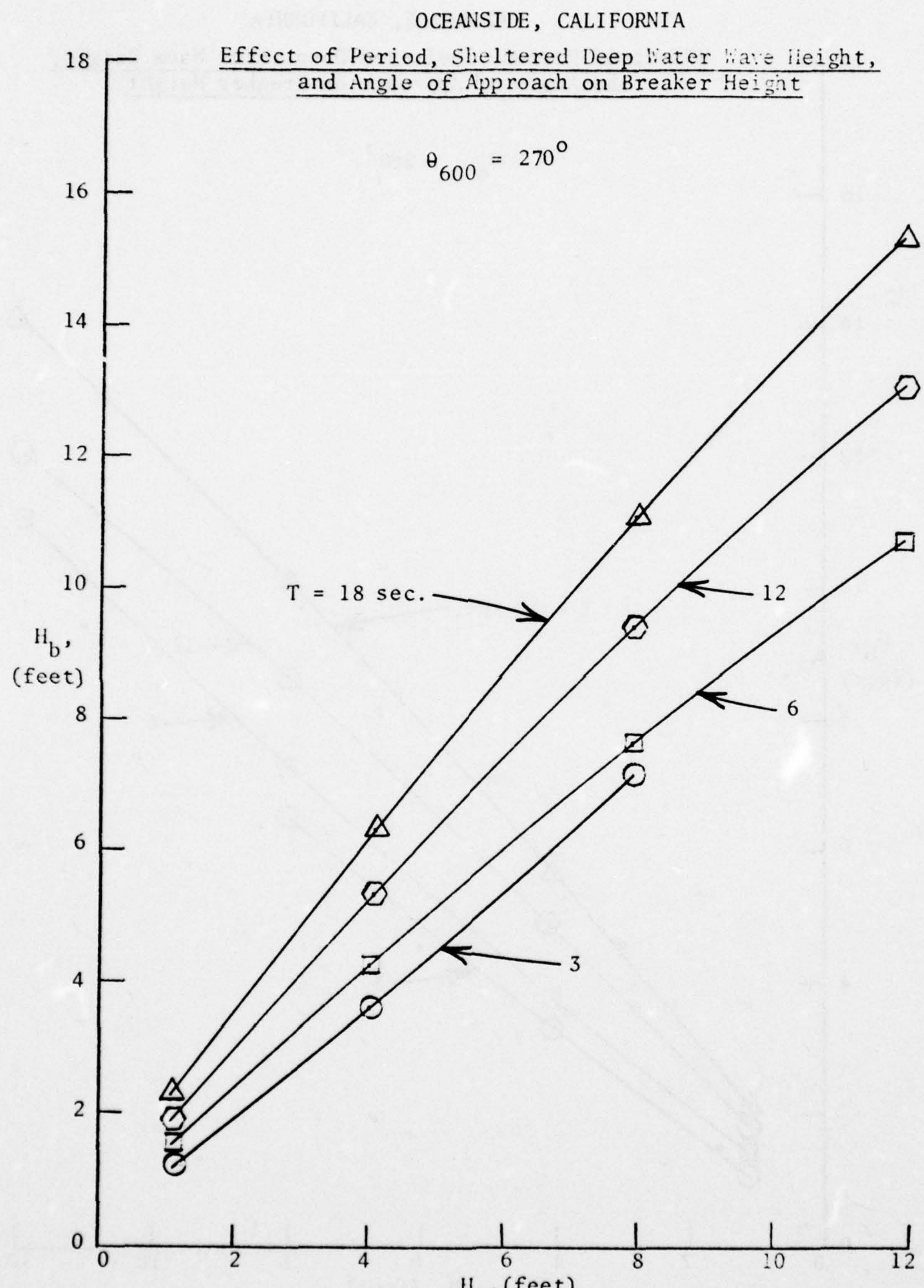

OCEANSIDE, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 250^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

OCEANSIDE, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height

$\theta_{600} = 260^{\circ}$

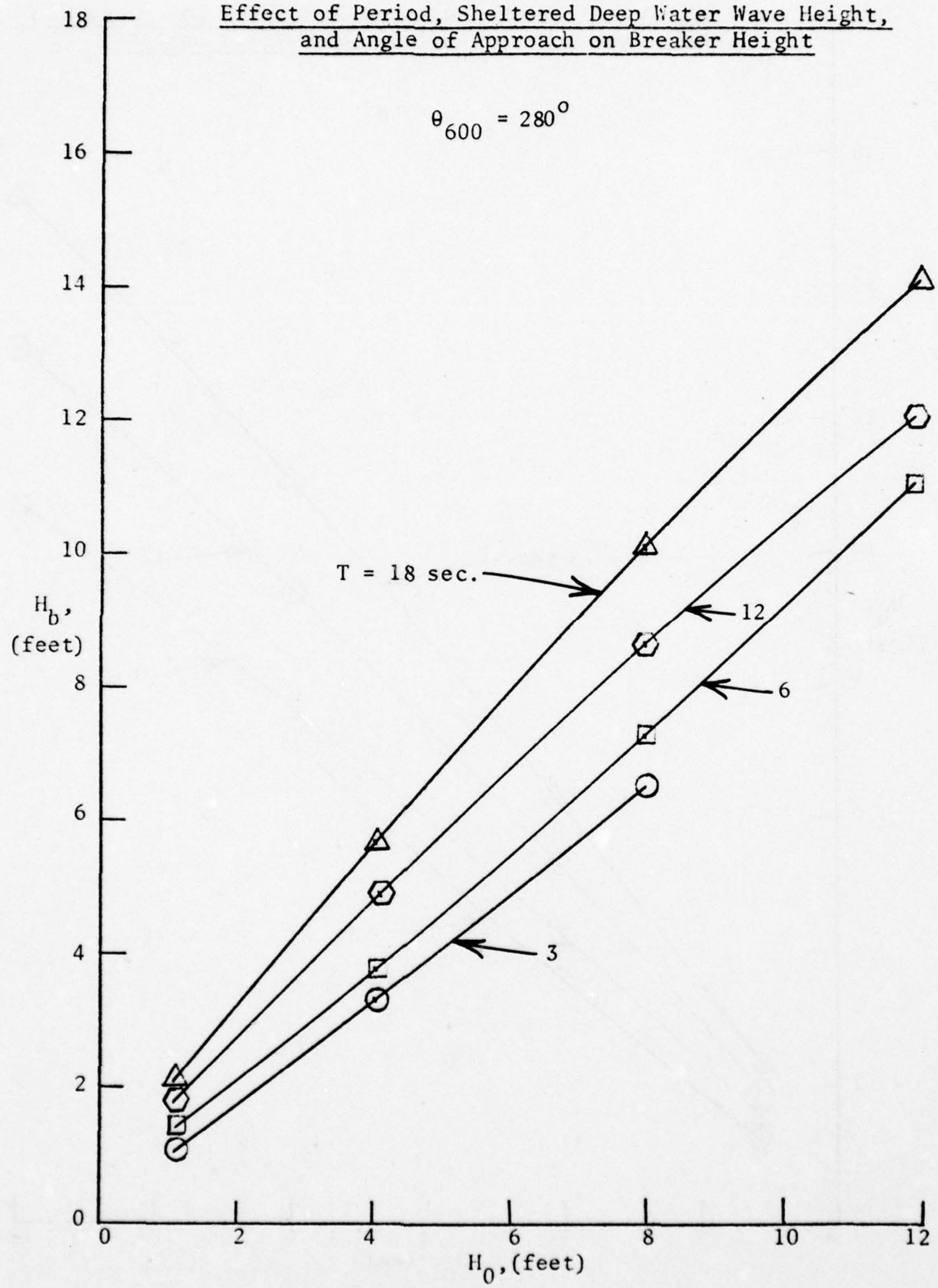




OCEANSIDE, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 270^{\circ}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

OCEANSIDE, CALIFORNIA

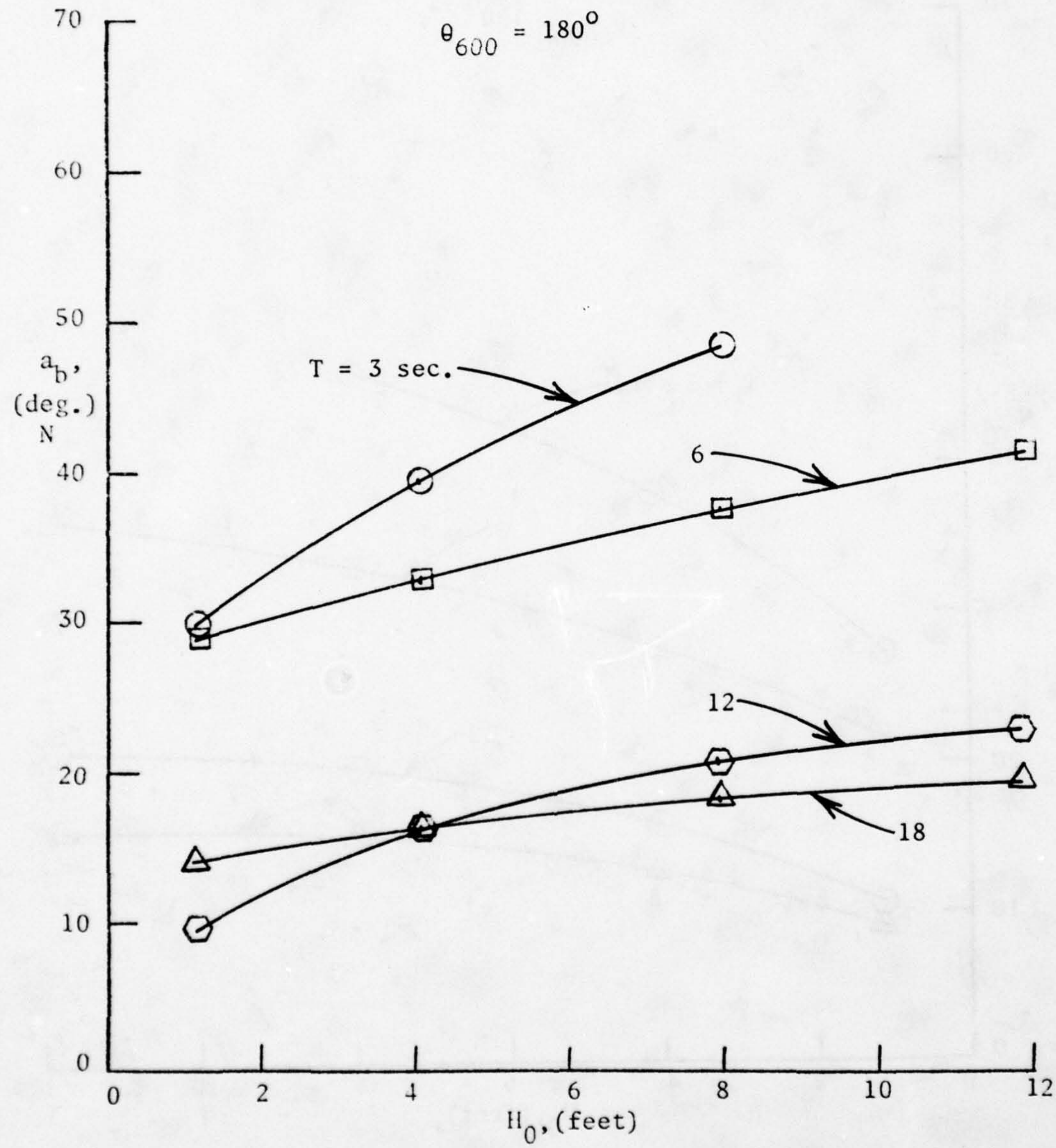
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height



APPENDIX V: EFFECT OF PERIOD, SHELTERED DEEP WATER WAVE HEIGHT, AND ANGLE OF APPROACH ON BREAKER ANGLE, ENCINITAS, CALIFORNIA

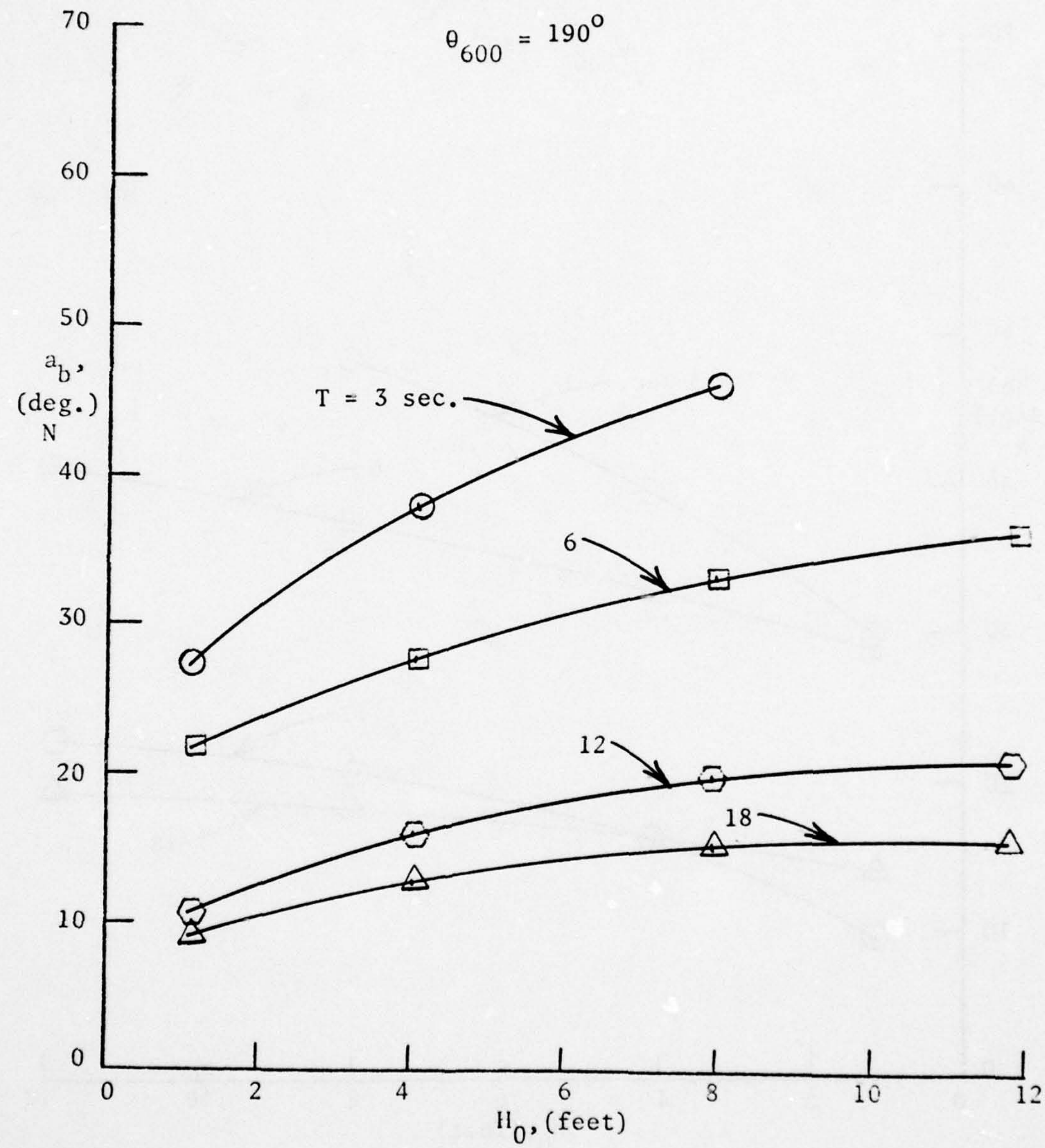
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



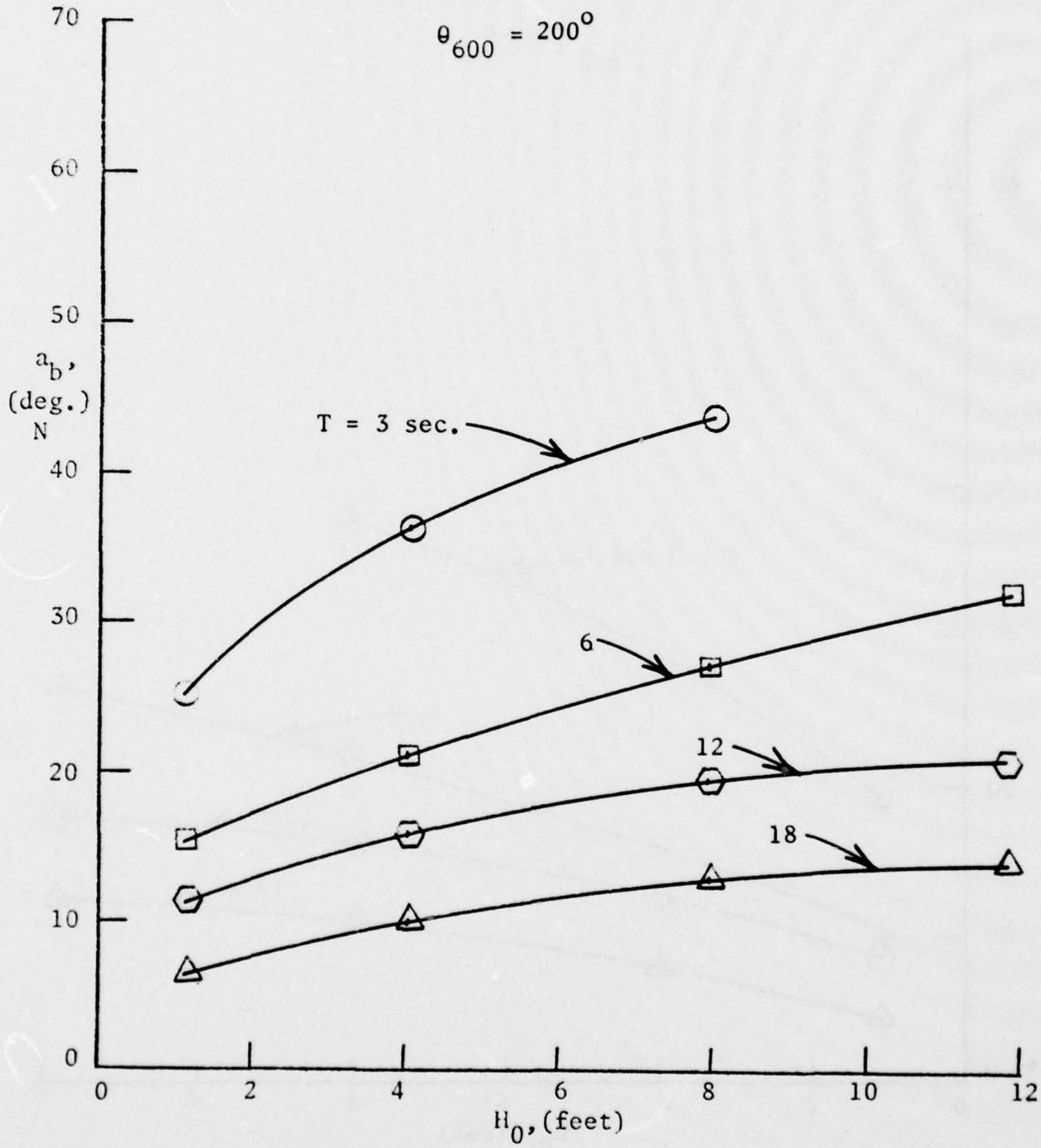
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



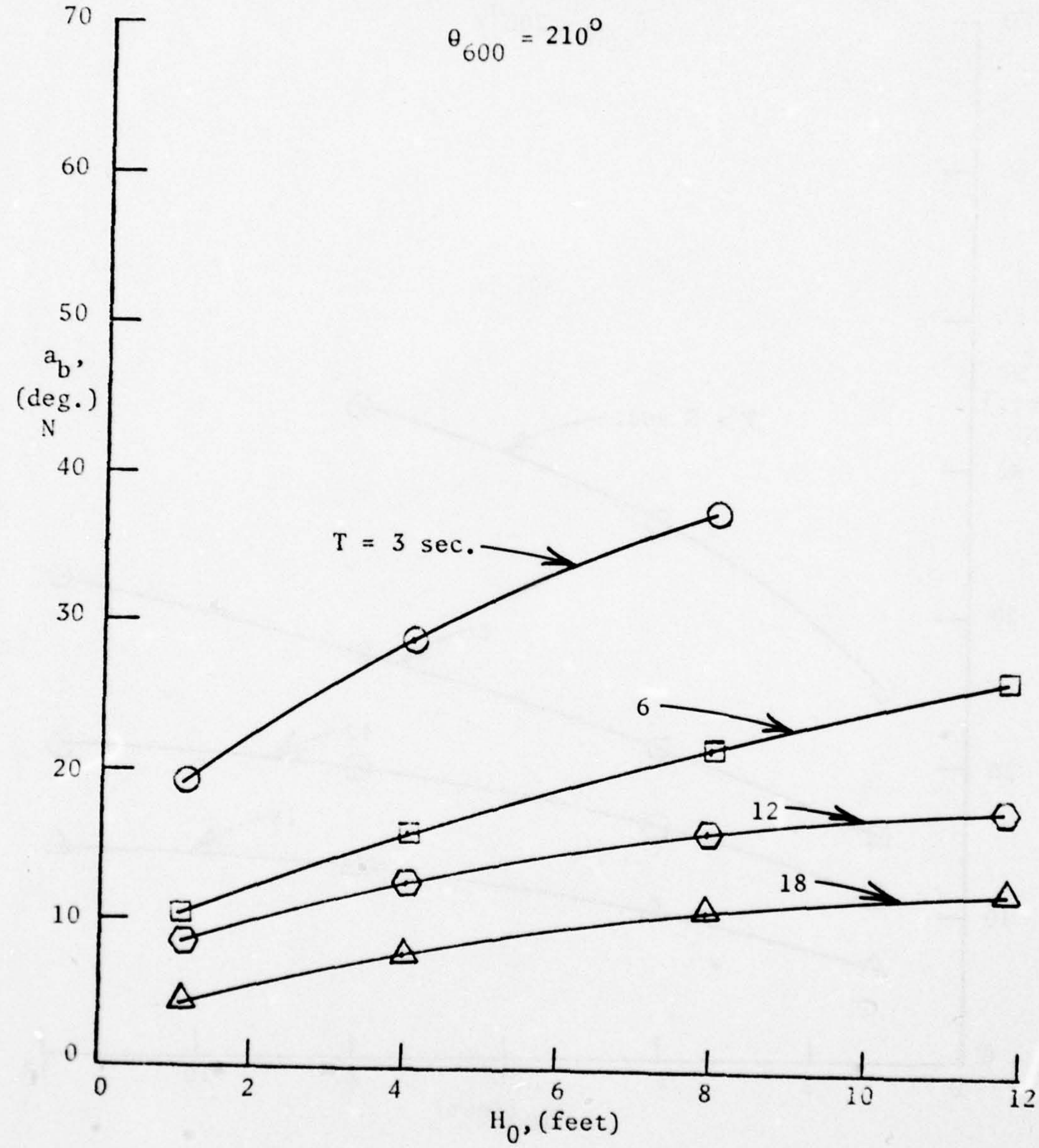
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



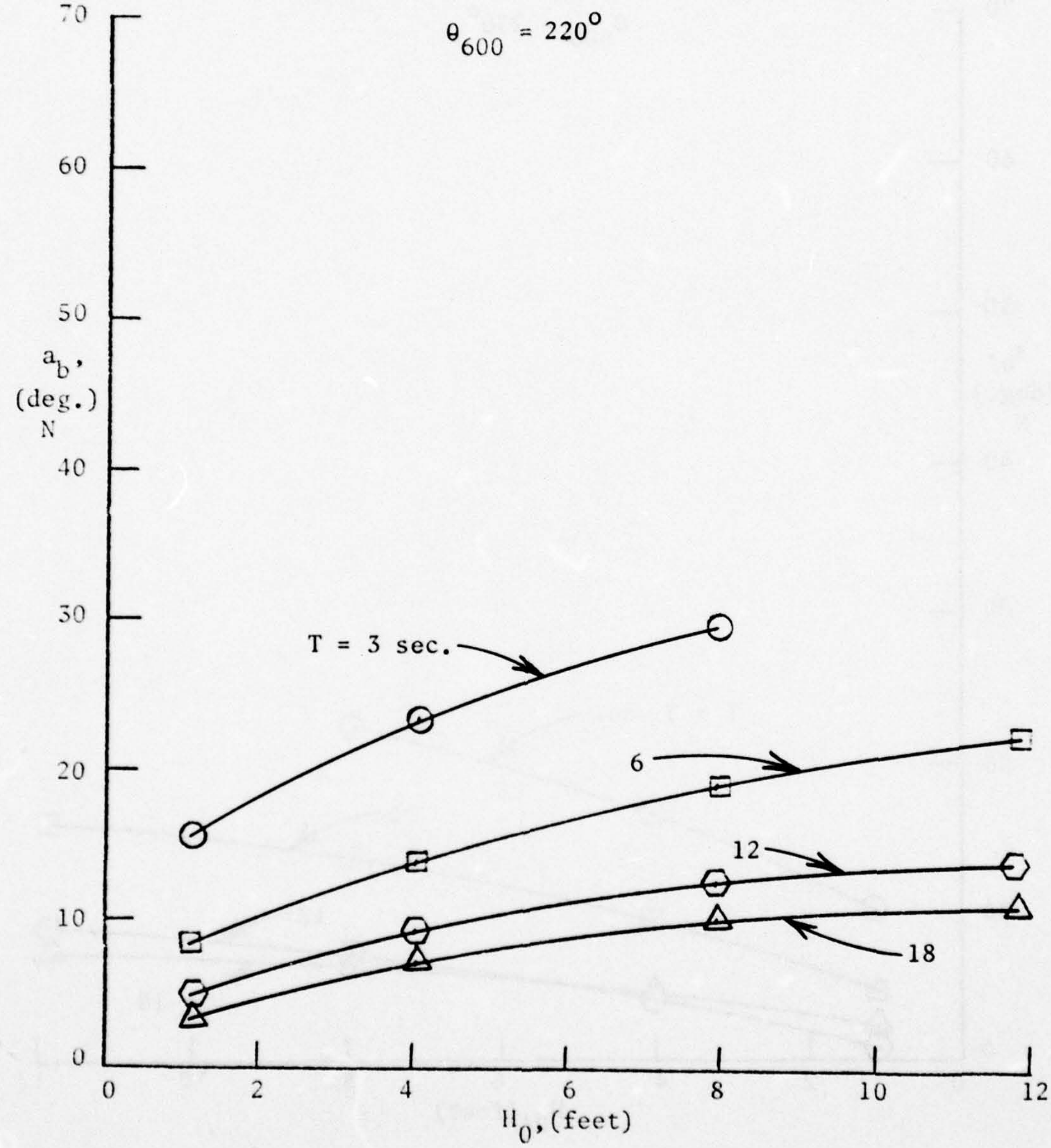
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



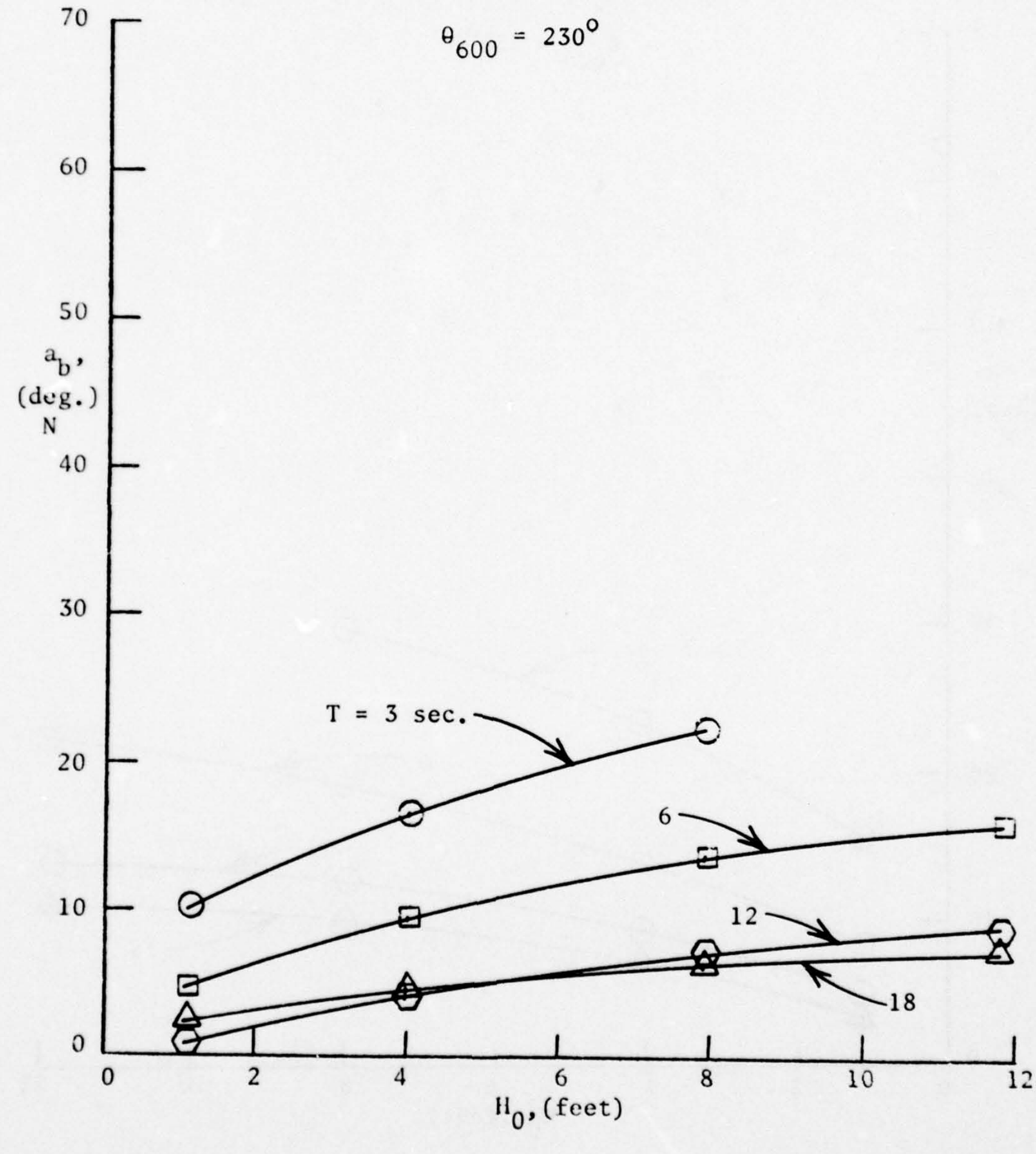
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



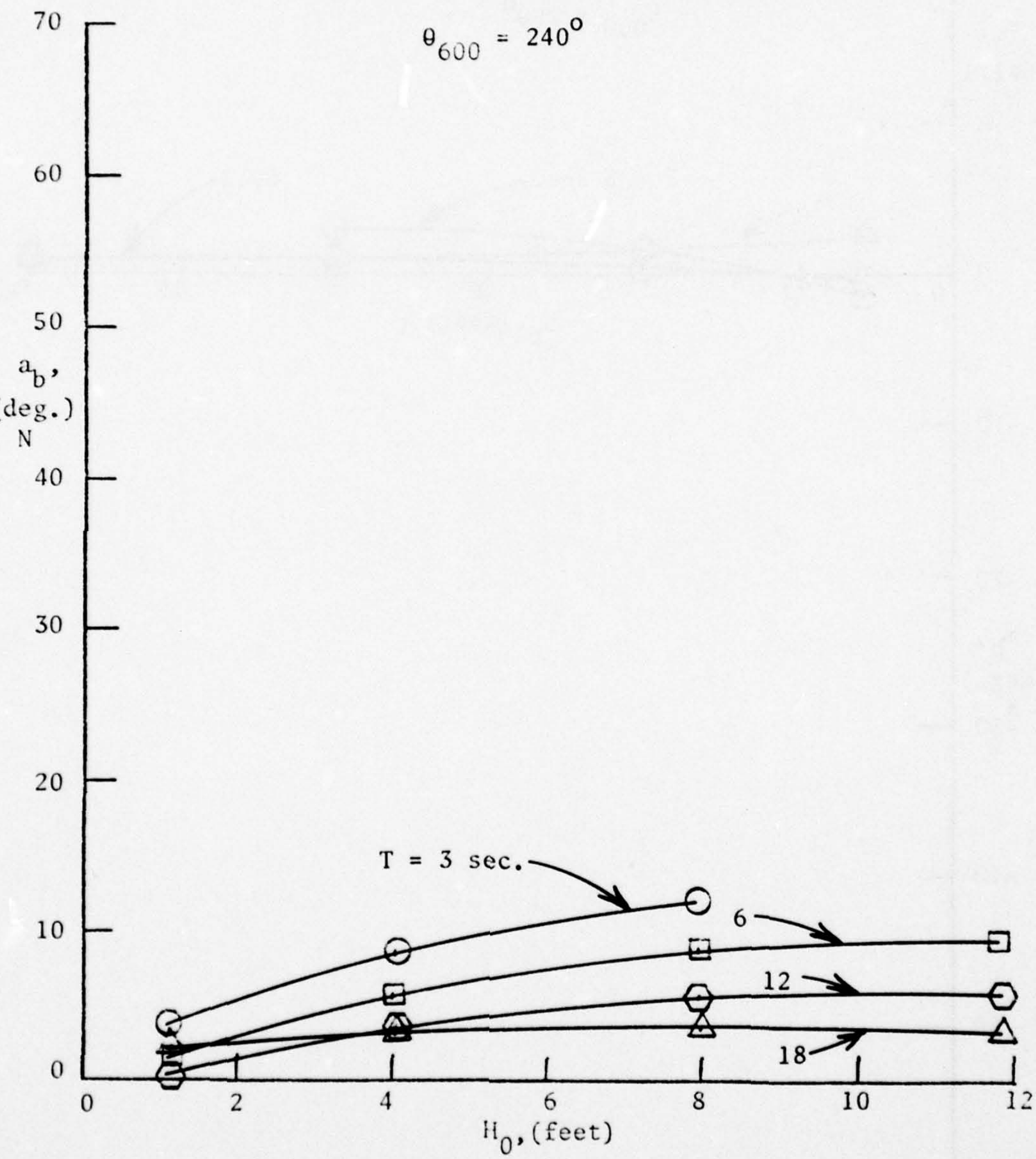
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



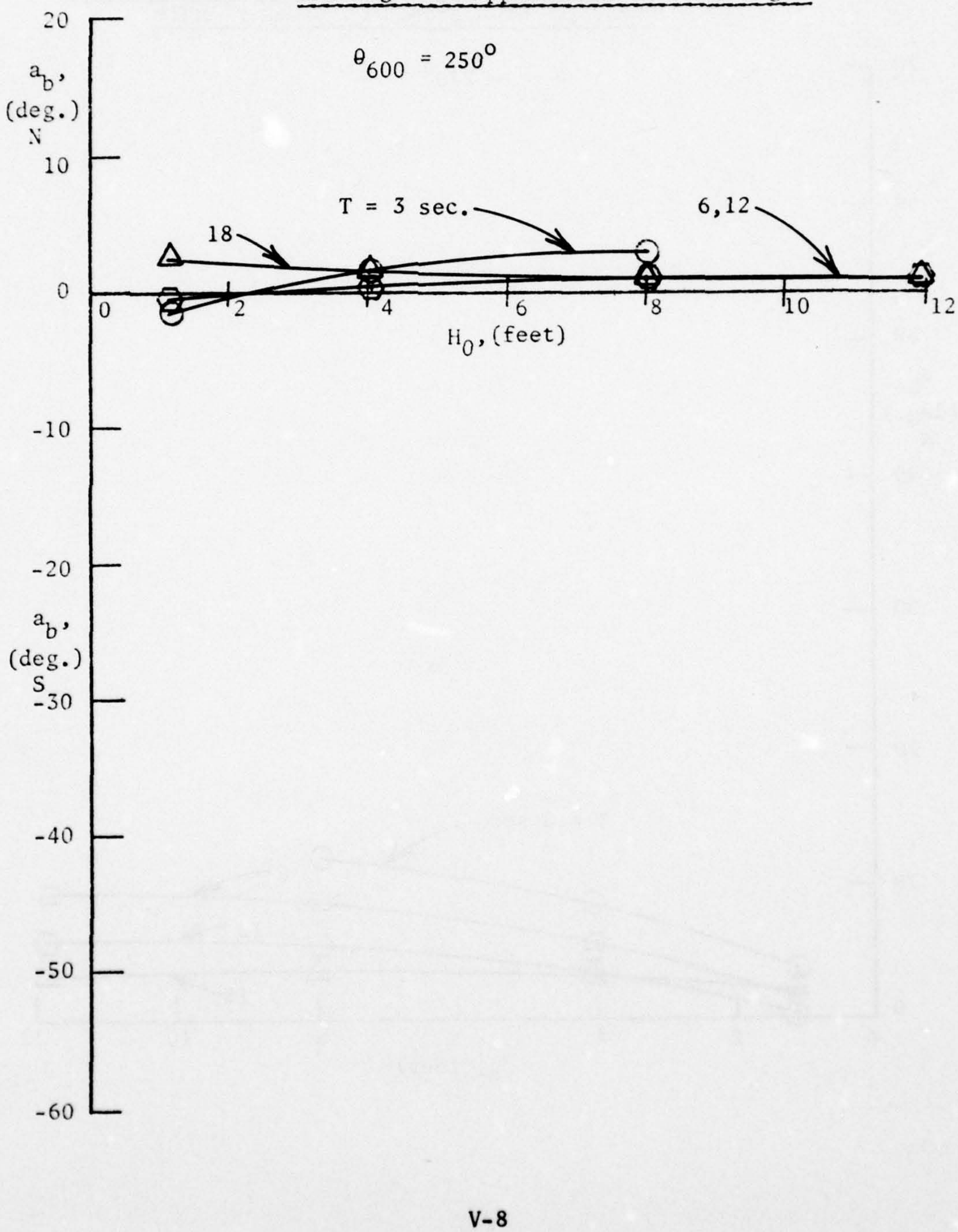
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



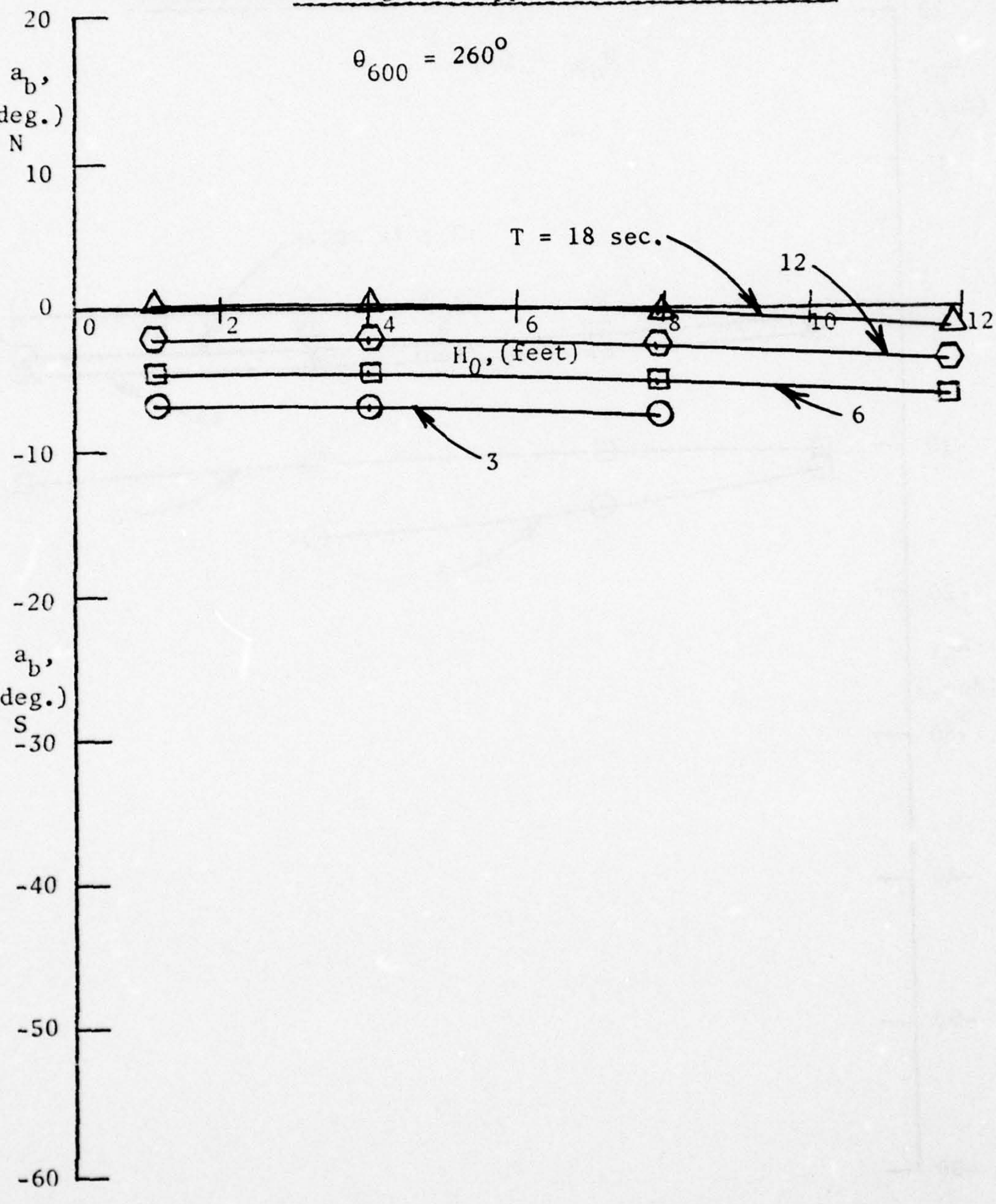
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



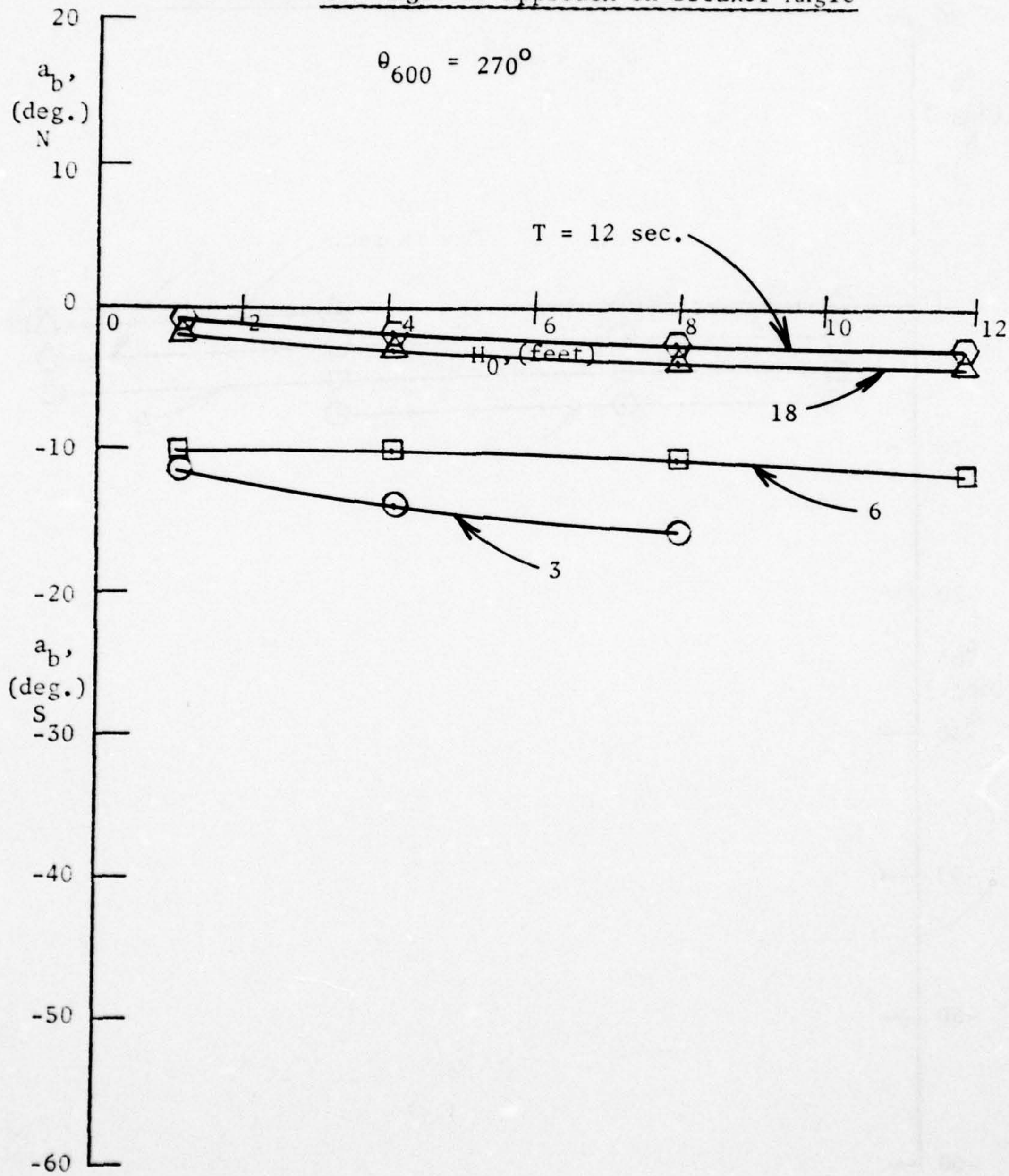
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



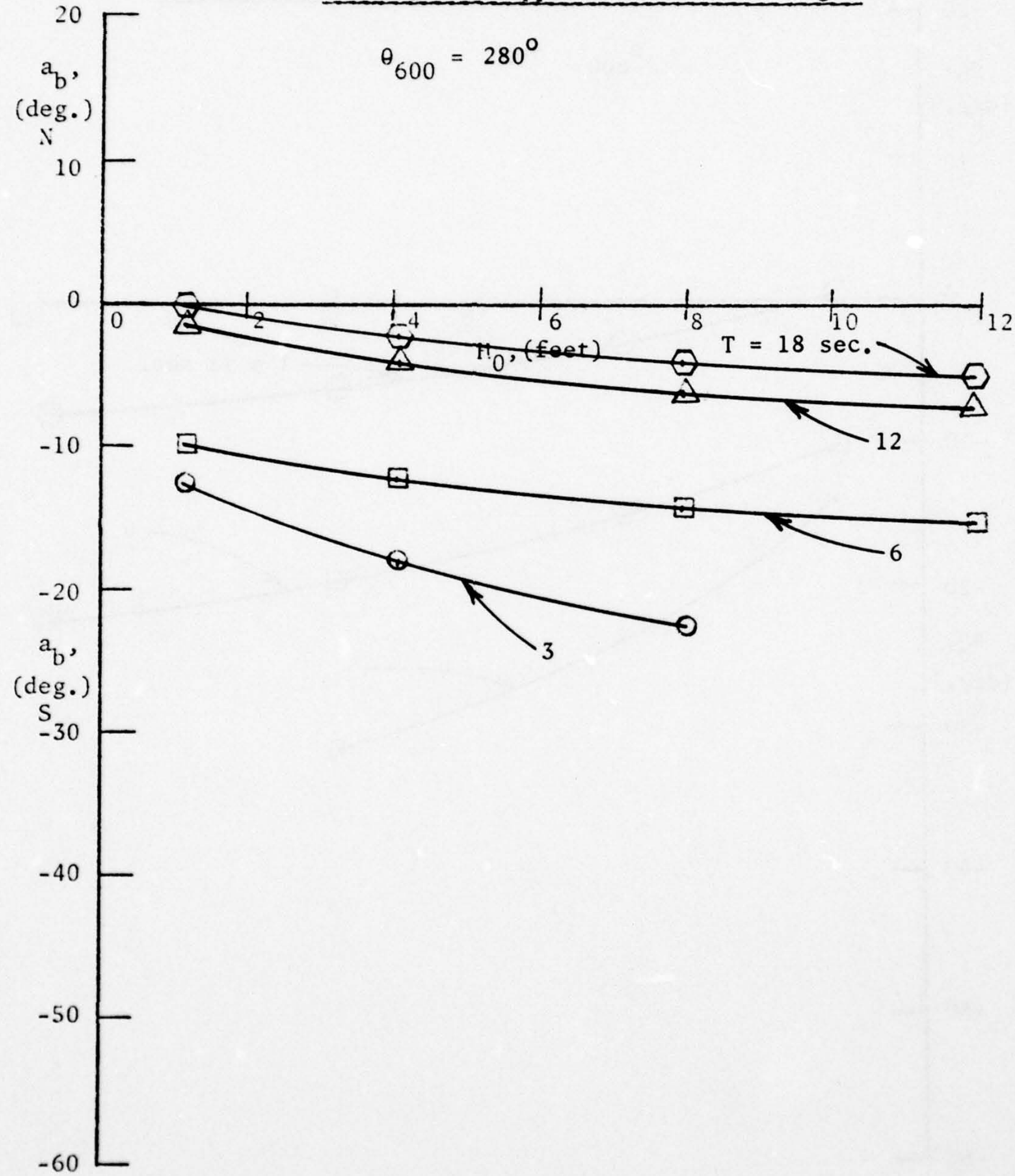
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



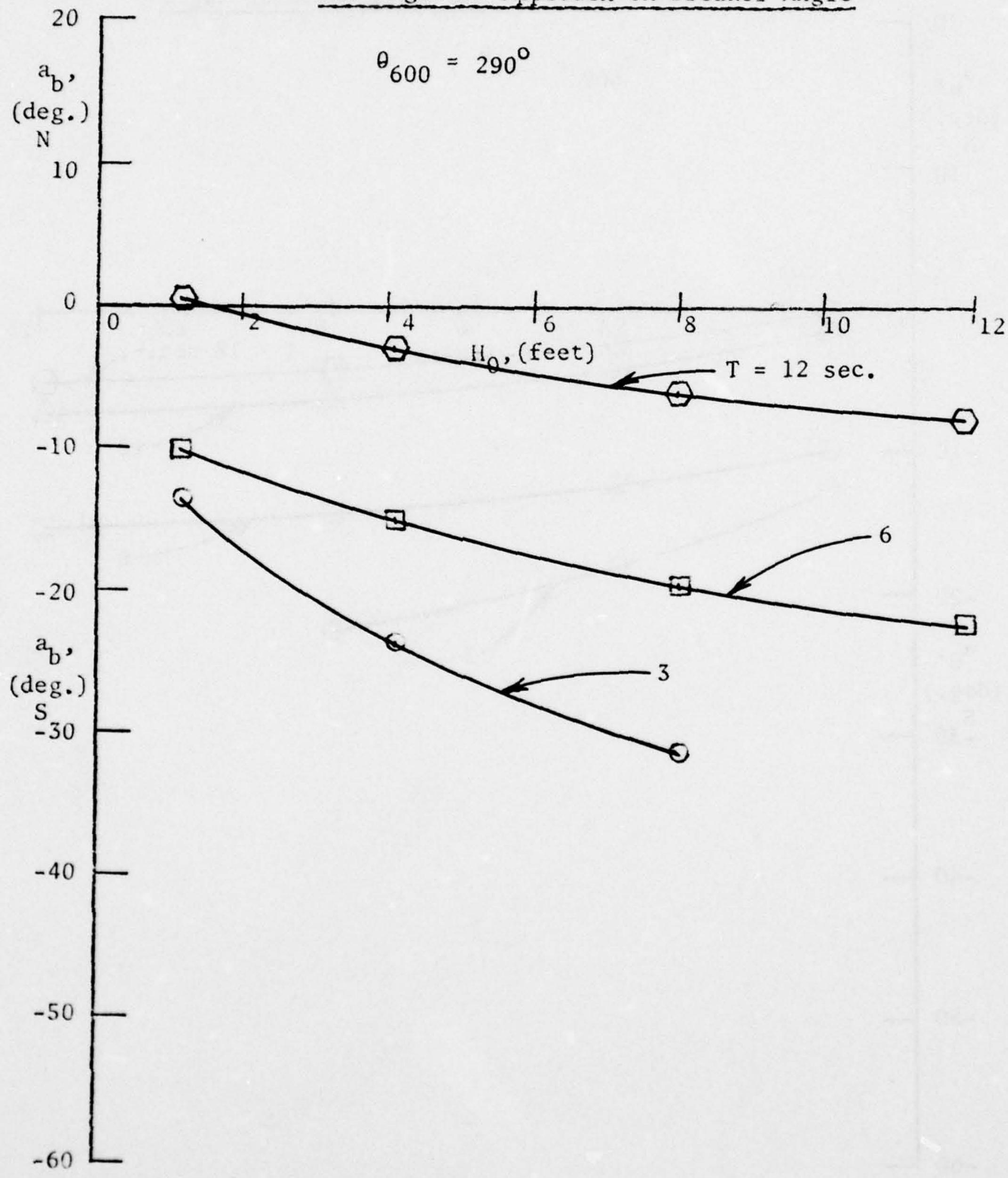
ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle

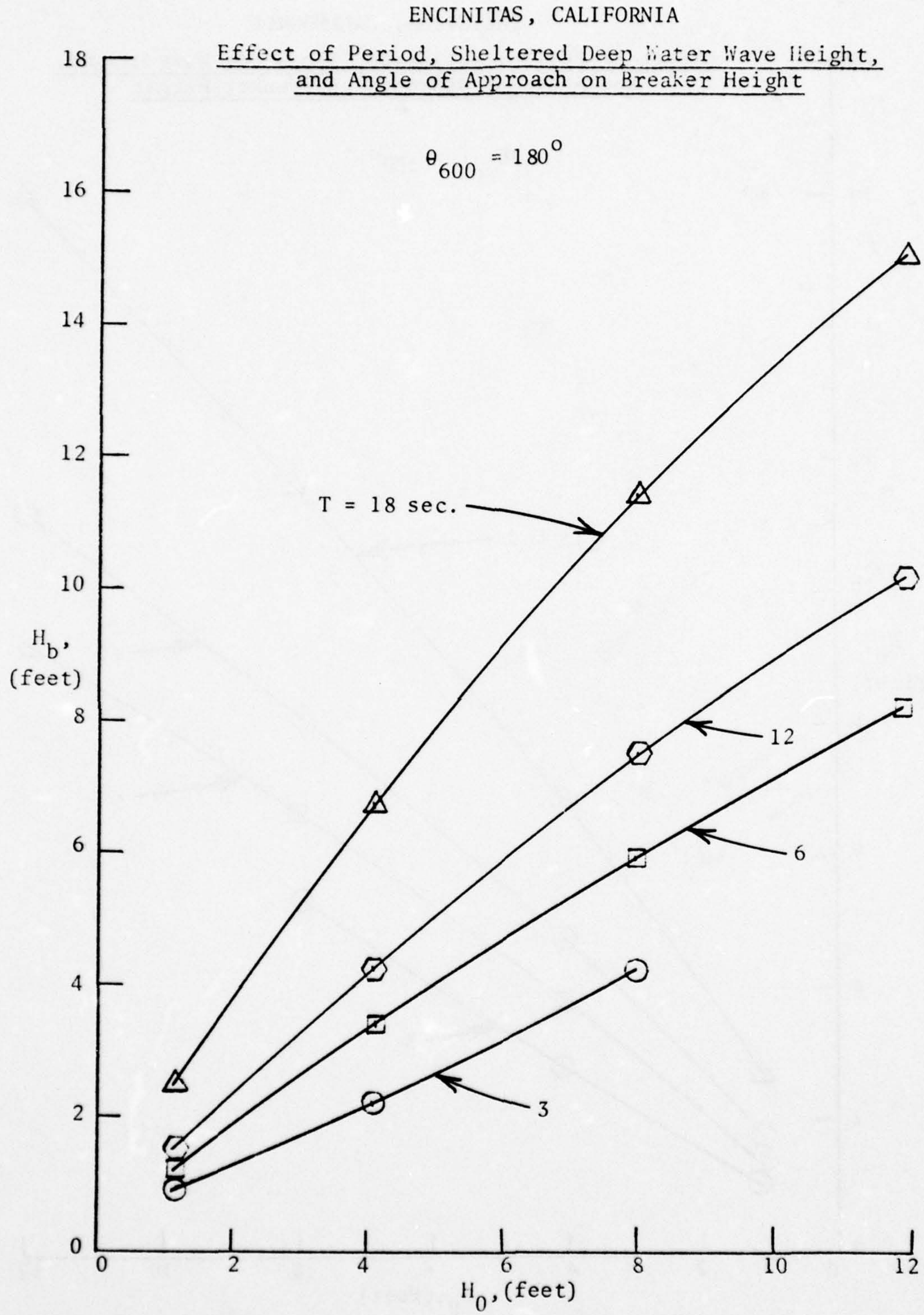


ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Angle



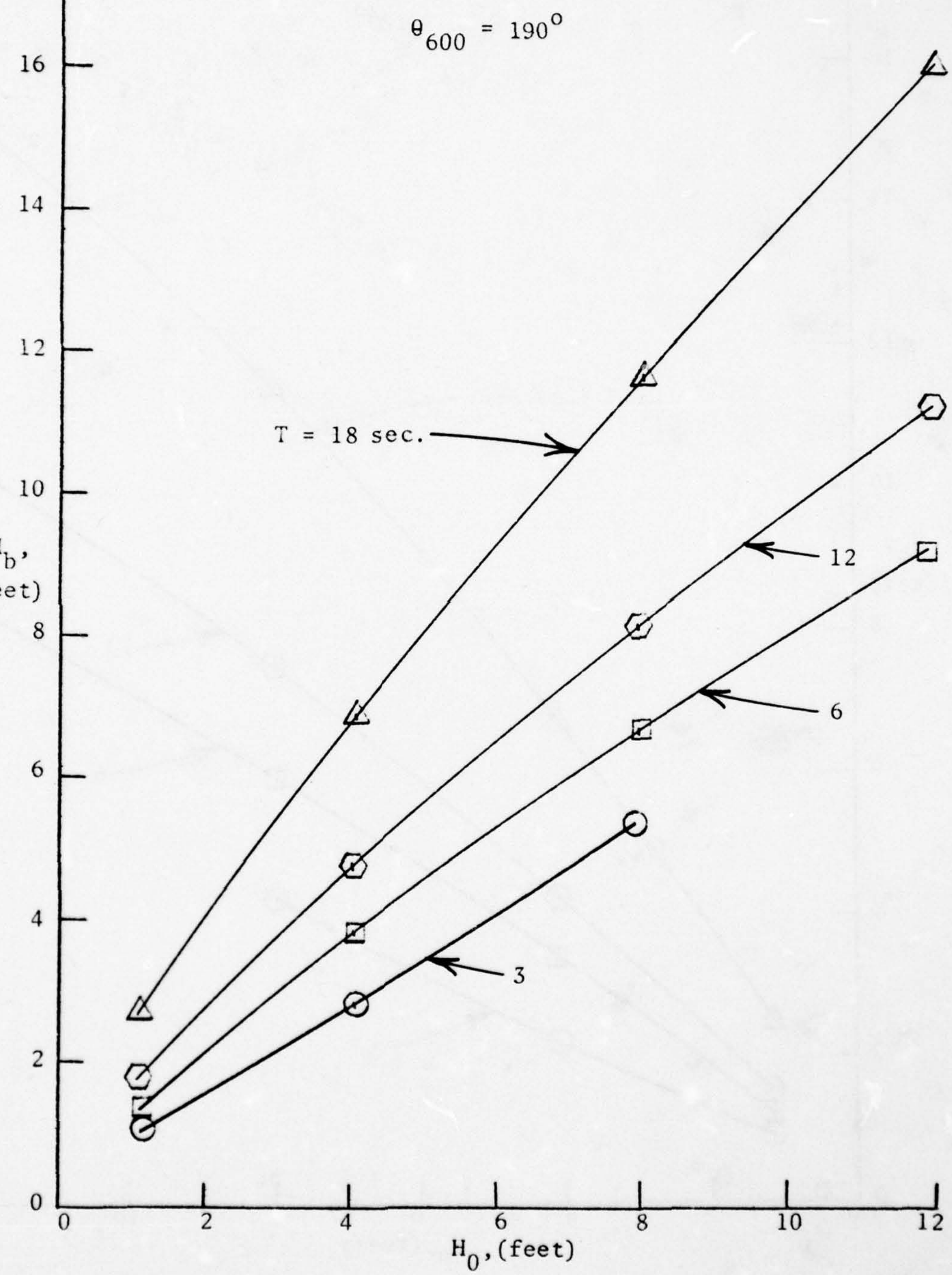
APPENDIX VI: EFFECT OF PERIOD, SHELTERED DEEP WATER WAVE HEIGHT, AND ANGLE OF APPROACH ON BREAKER HEIGHT, ENCINITAS, CALIFORNIA


ENCINITAS, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 180^{\circ}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

231

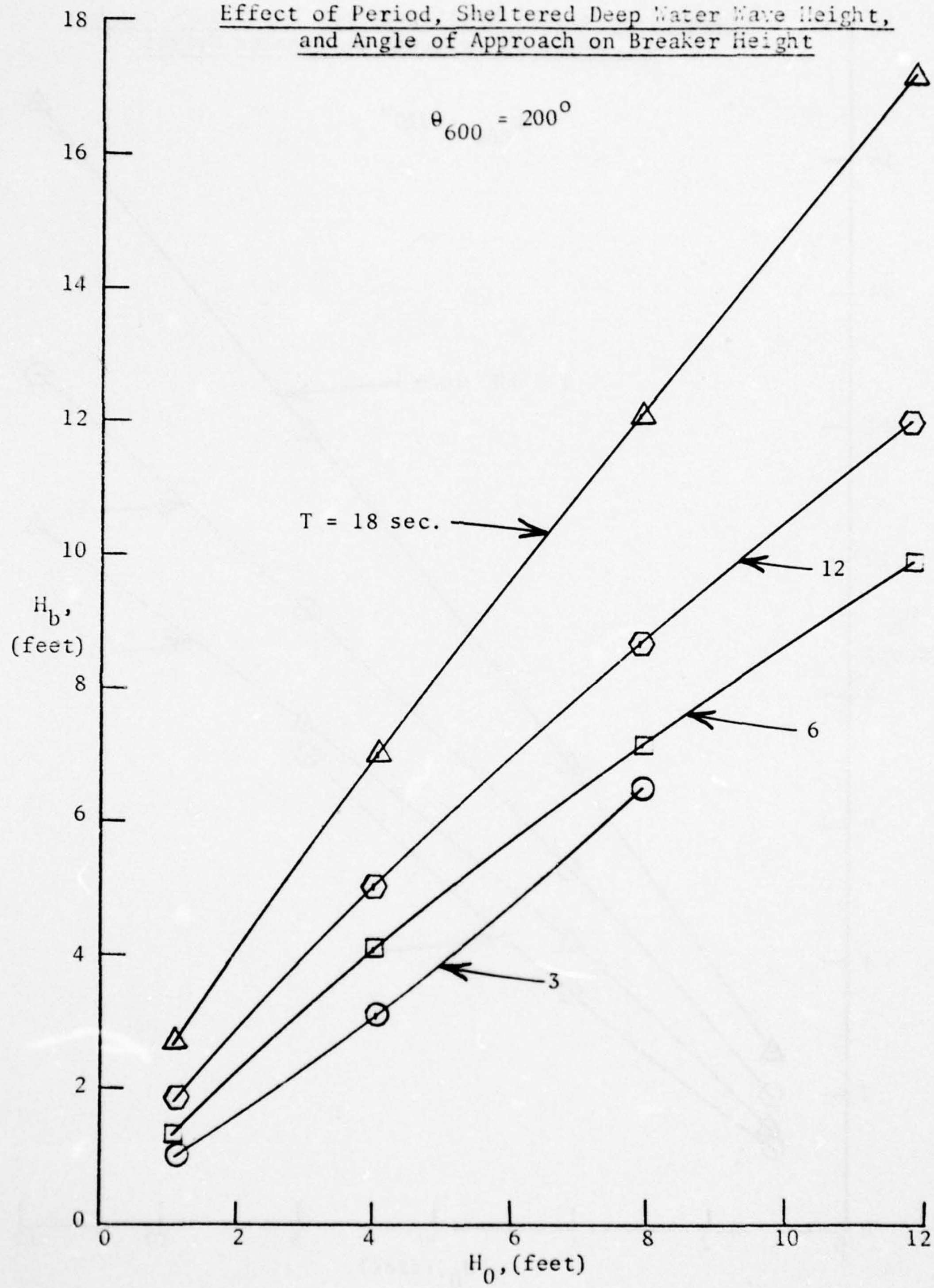
ENCINITAS, CALIFORNIA

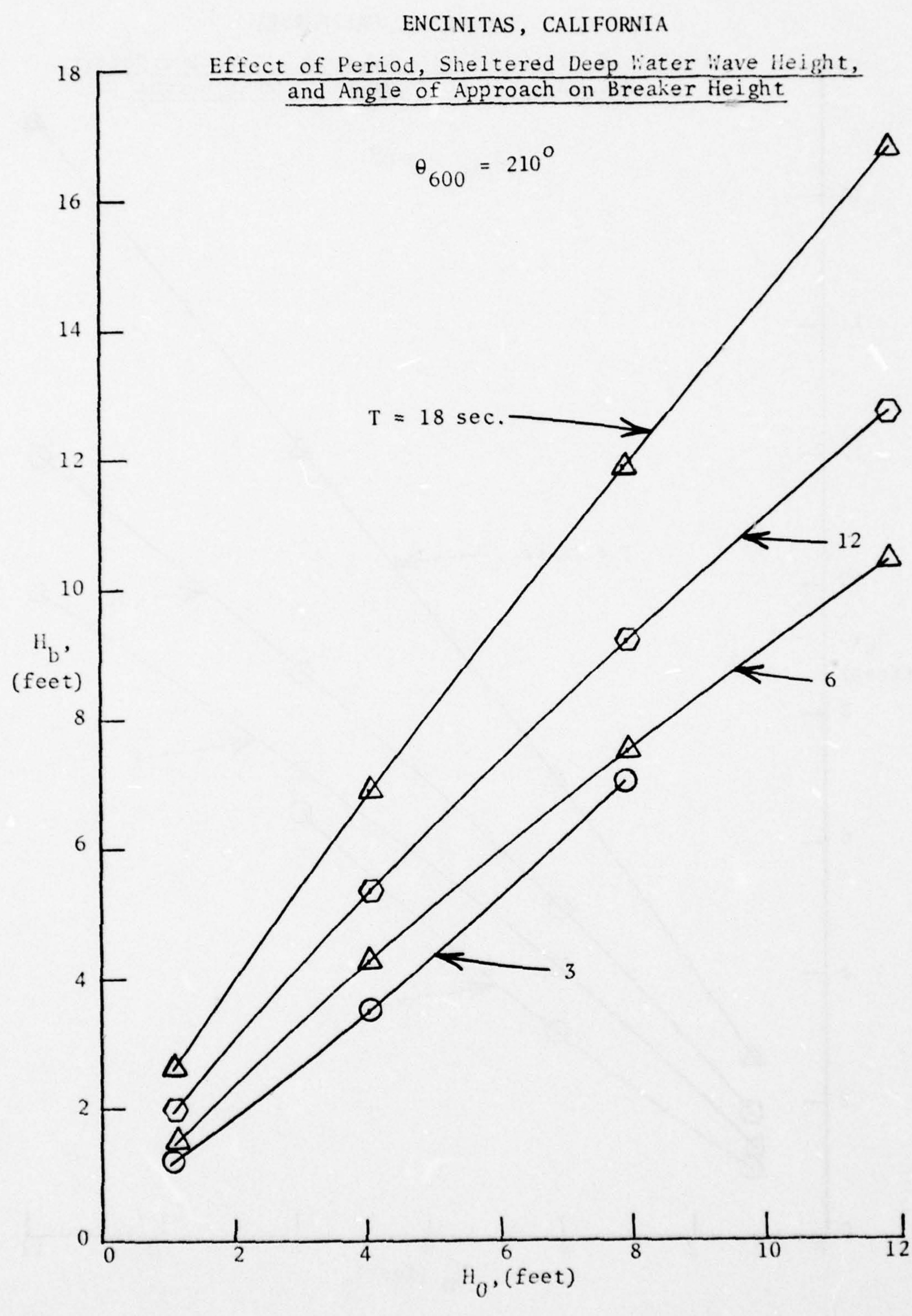
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height

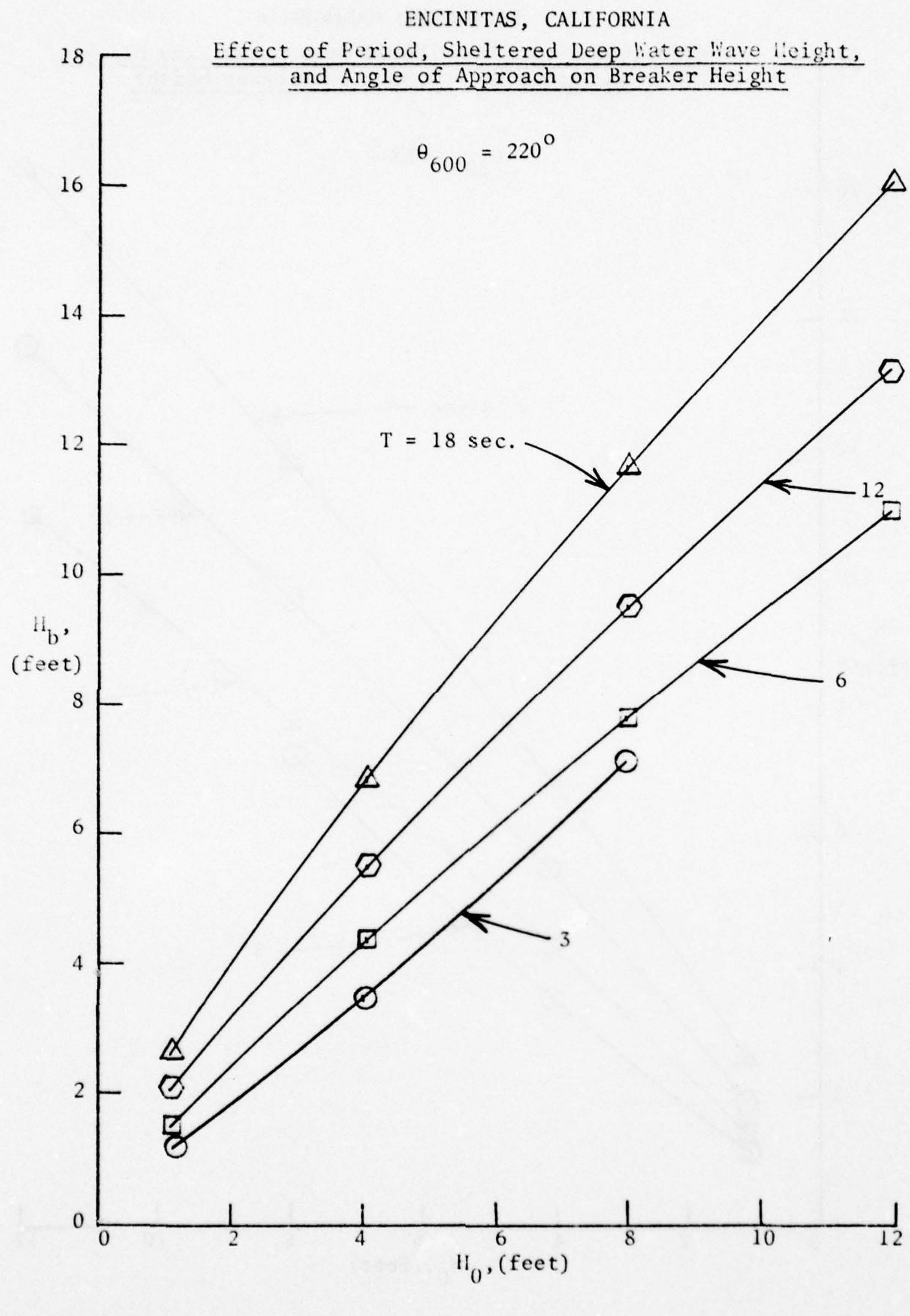


ENCINITAS, CALIFORNIA

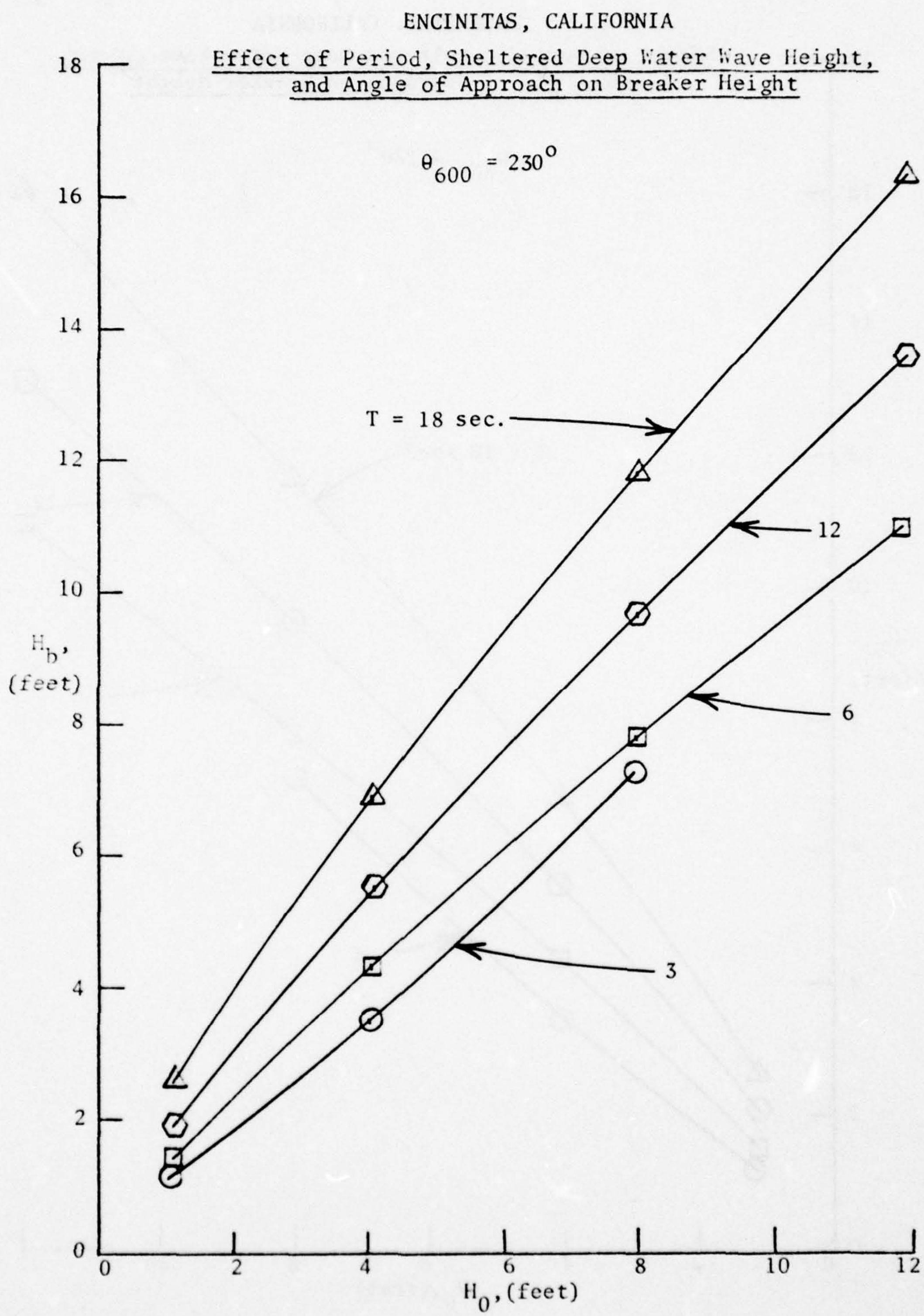
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height



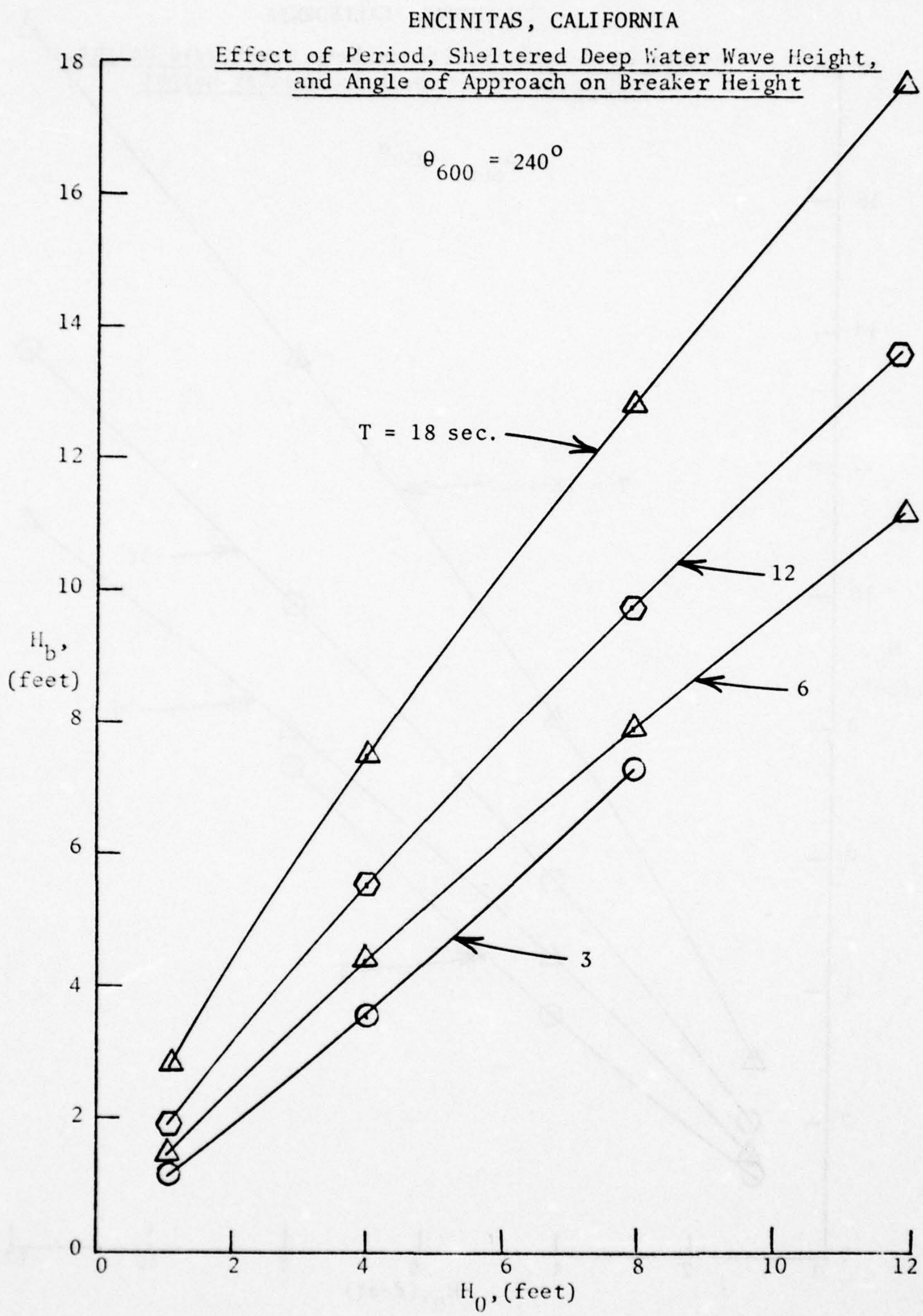

ENCINITAS, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 210^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

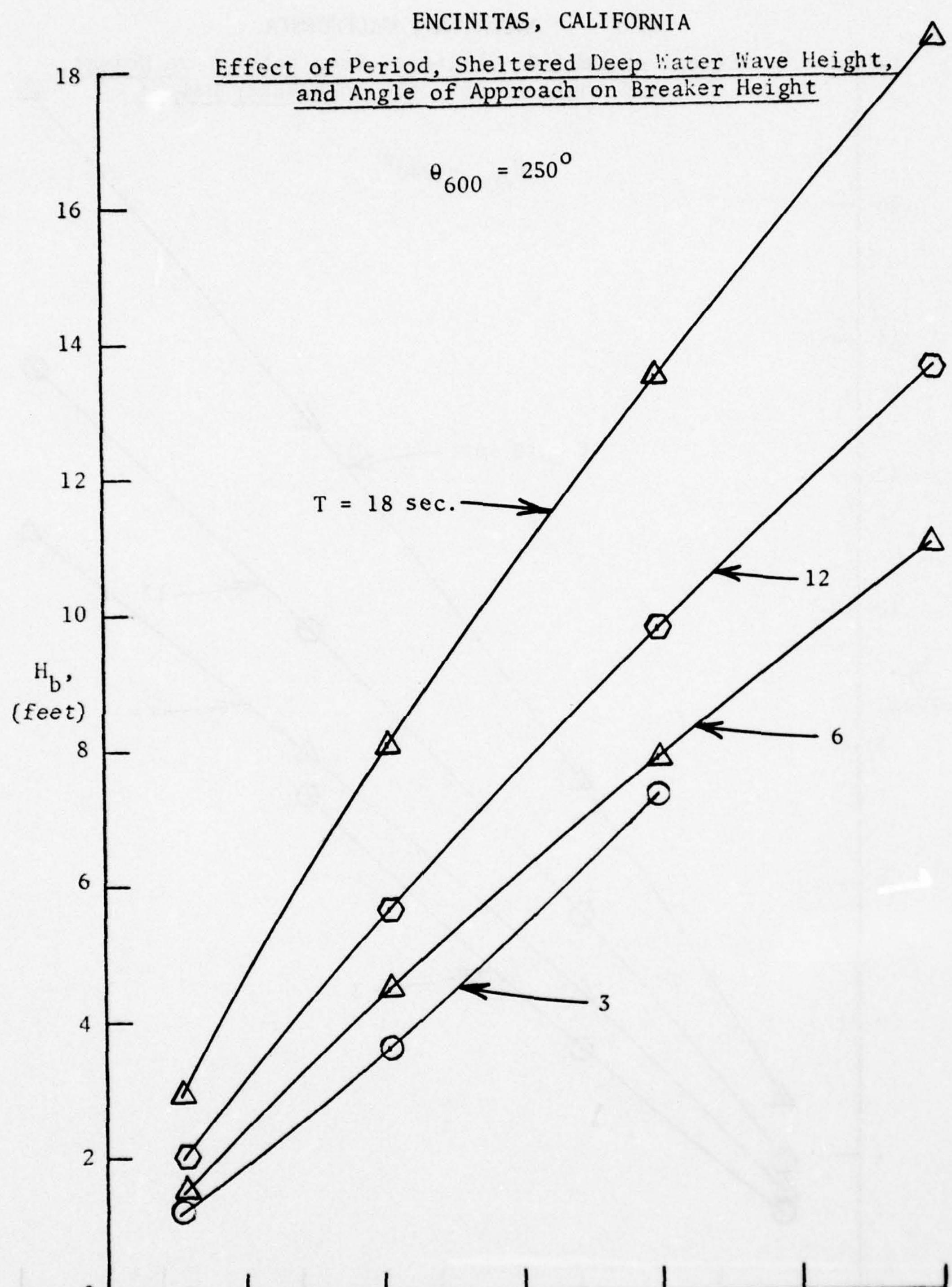


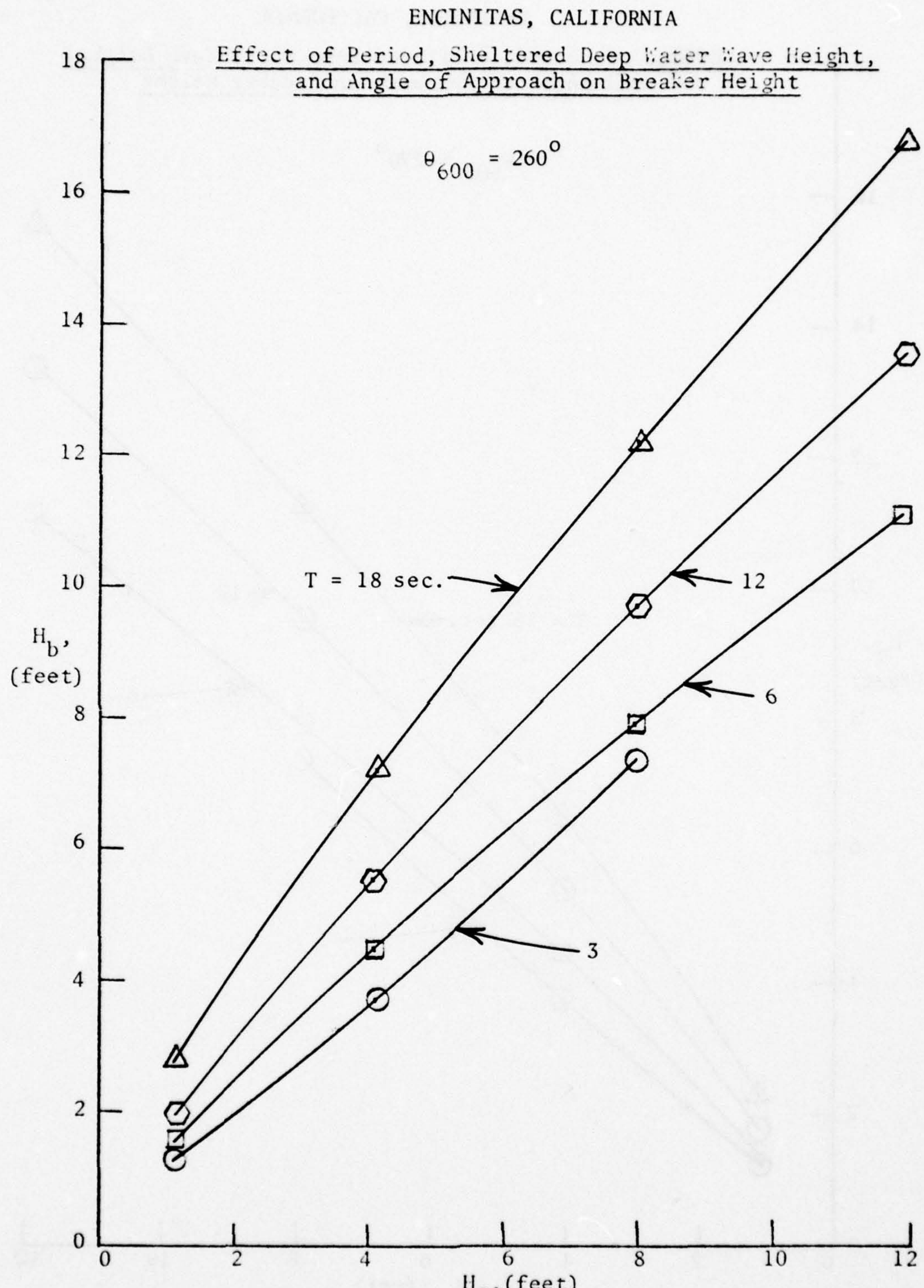
ENCINITAS, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
θ600 = 220°
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

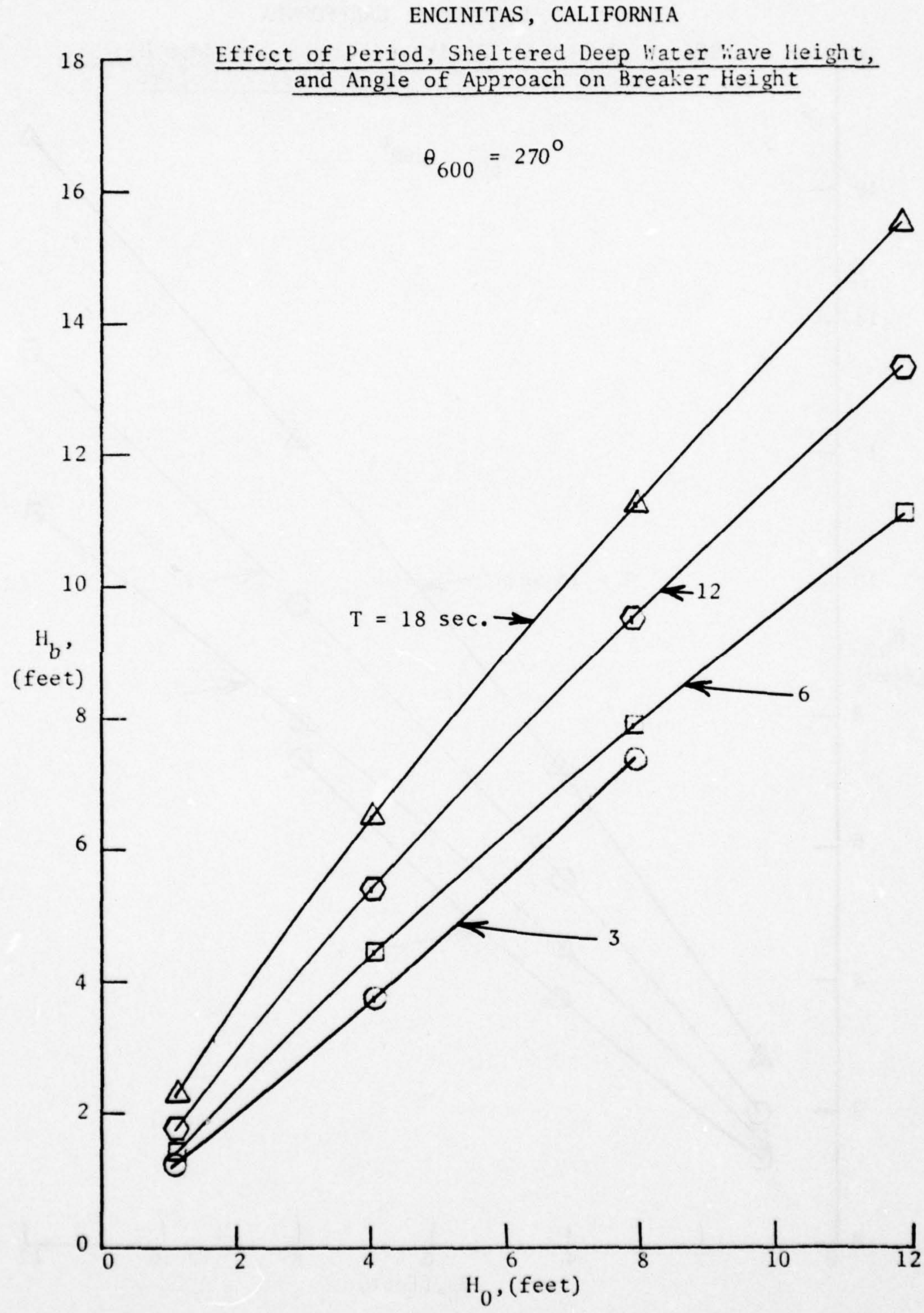


ENCINITAS, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
θ600 = 230°
T = 18 sec.
12
6
3
Hb, (feet)
H0, (feet)
0
2
4
6
8
10
12
14
16
18


ENCINITAS, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 240^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

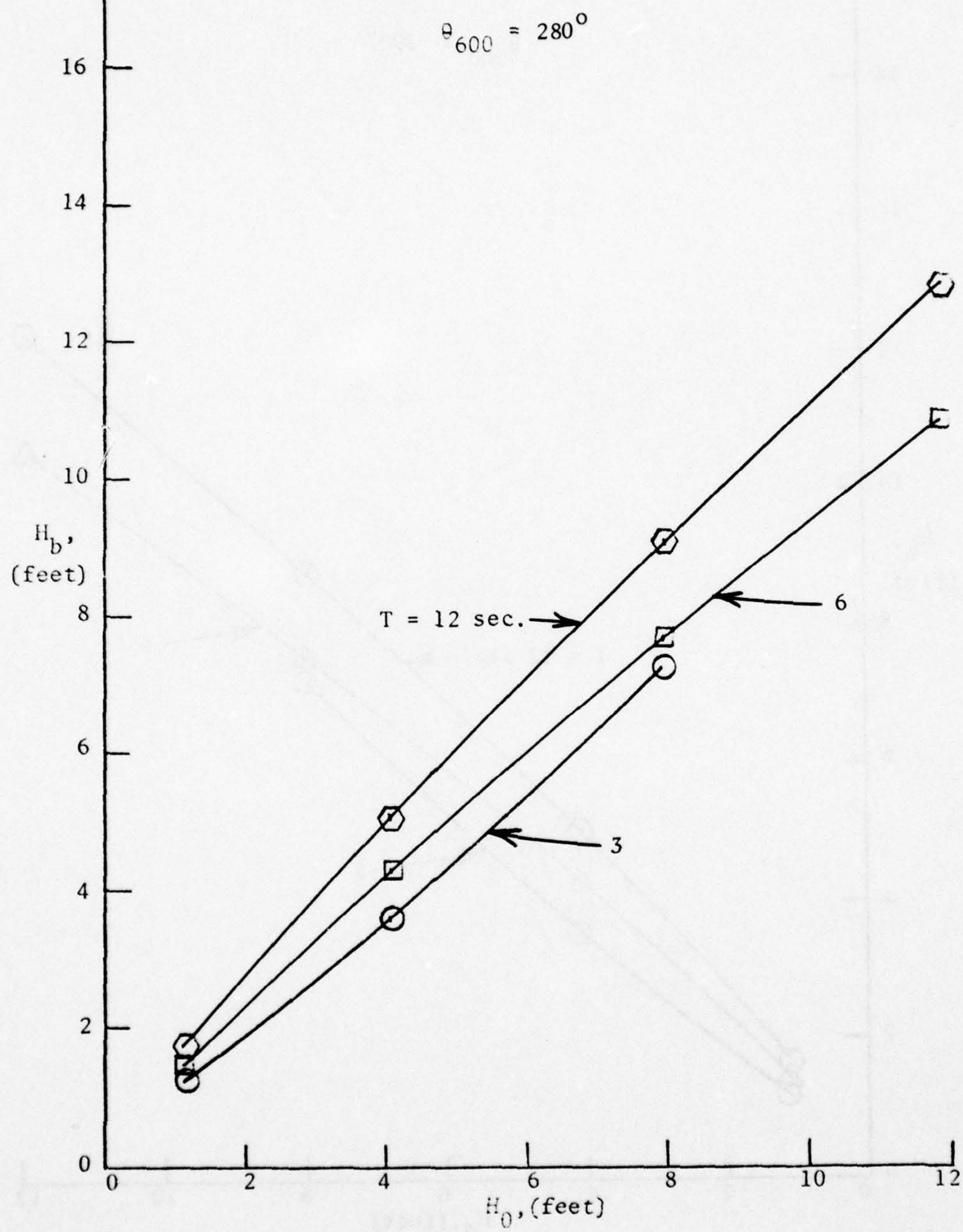

ENCINITAS, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 250^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18


ENCINITAS, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
$\theta_{600} = 260^{o}$
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18


ENCINITAS, CALIFORNIA
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height
θ600 = 270°
T = 18 sec.
12
6
3
H_b, (feet)
H_0, (feet)
0
2
4
6
8
10
12
14
16
18

ENCINITAS, CALIFORNIA

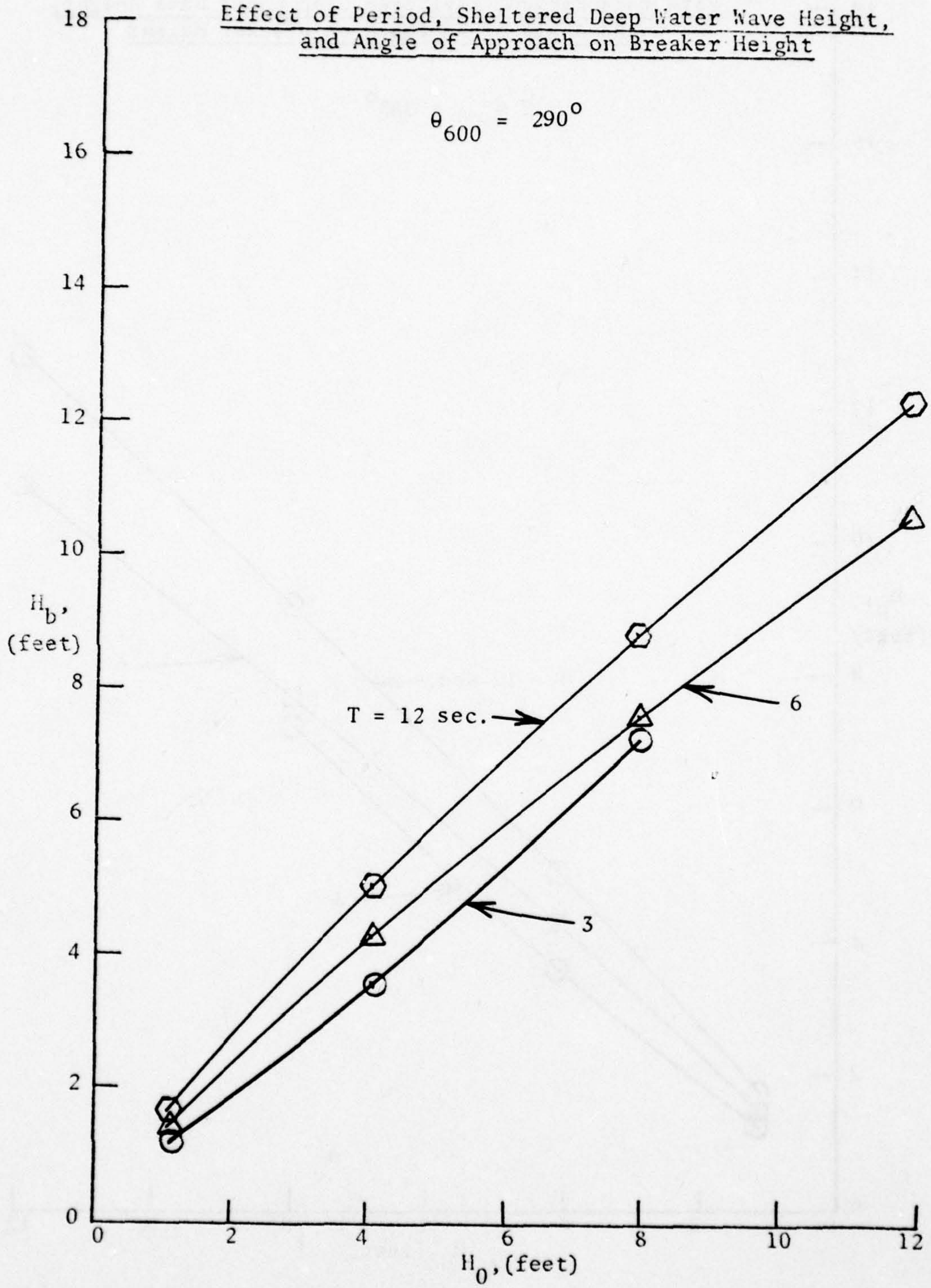
Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height



ENCINITAS, CALIFORNIA

Effect of Period, Sheltered Deep Water Wave Height, and Angle of Approach on Breaker Height

$\theta_{600} = 290^{\circ}$



APPENDIX VII: OPEN-OCEAN DEEP WATER WAVE STATISTICS

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 155^{o} - 165^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	2.1	1.2	1.0	0.1	
1.0-1.9	3.5	3.0	1.7	0.2	
2.0-2.9	1.2	1.1	0.5	0.1	
3.0-3.9	0.2	0.2	0.1	0.1	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisers, January 1961

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 165° - 175°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	1.1	1.1	0.5	0.1	
1.0-1.9	2.5	1.8	0.8	0.4	
2.0-2.9	0.3	0.5	0.1	0.1	
3.0-3.9	0.1				
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisers, January 1961

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	1.8	1.0	0.4	0.2	
1.0-1.9	2.2	1.4	0.5	0.1	
2.0-2.9	0.4	0.1	0.1		
3.0-3.9			0.1		
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisers, January 1961

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 185^{o} - 195^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.4	0.3	0.2	0.1	
1.0-1.9	0.5	0.3	0.1		
2.0-2.9	0.1	0.1			
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisers, January 1961

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	1.2	0.5	0.1	0.2	
1.0-1.9	1.2	0.9	0.2	0.1	
2.0-2.9	0.5	0.7	0.2	0.1	
3.0-3.9		0.2	0.2	0.1	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisers, January 1961

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	1.1	0.5	0.1	0.1	
1.0-1.9	3.1	2.4	0.3		
2.0-2.9	0.3	0.5	0.2	0.1	
3.0-3.9	0.1	0.2	0.2	0.1	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisers, January 1961

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.7	0.1	0.1		
1.0-1.9	2.9	1.3	0.1	0.1	
2.0-2.9	2.1	2.1	0.5	0.1	
3.0-3.9	0.4	0.7	0.4	0.1	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisers, January 1961

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 225° - 235°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.7	0.4			
1.0-1.9	2.8	3.0	0.2	0.1	
2.0-2.9	2.0	1.3	0.2		
3.0-3.9	0.4	0.2	0.2	0.1	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisers, January 1961

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 125^{o} - 135^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.05					
3.3-4.9	0.02					
4.9-6.6	0.01	0.01				
6.6-8.2		0.01				
8.2-9.8						
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 135^o - 145^o

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.04					
3.3-4.9	0.03					
4.9-6.6		0.01				
6.6-8.2						
8.2-9.8						
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water
Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 145^{o} - 155^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.06					
3.3-4.9	0.02					
4.9-6.6	0.01	0.01				
6.6-8.2						
8.2-9.8						
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = $155^\circ - 165^\circ$

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.05					
3.3-4.9	0.04					
4.9-6.6	0.01	0.01				
6.6-8.2		0.01				
8.2-9.8						
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water
Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 165° - 175°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.07					
3.3-4.9	0.04					
4.9-6.6	0.01	0.01				
6.6-8.2		0.01				
8.2-9.8		0.01				
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water
Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 175^{o}- 185^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.10					
3.3-4.9	0.04					
4.9-6.6		0.01				
6.6-8.2		0.01				
8.2-9.8		0.01				
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 185^{o} - 195^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.07					
3.3-4.9	0.03					
4.9-6.6	0.01	0.04				
6.6-8.2		0.03				
8.2-9.8		0.01				
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.09					
3.3-4.9	0.06					
4.9-6.6	0.01	0.05				
6.6-8.2		0.03				
8.2-9.8			0.01			
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water
Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.07					
3.3-4.9	0.05					
4.9-6.6	0.02					
6.6-8.2		0.06				
8.2-9.8		0.04				
9.8-13.1		0.01				
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water
Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = $215^{o} - 225^{o}$

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.10					
3.3-4.9	0.06					
4.9-6.6	0.01	0.05				
6.6-8.2		0.04				
8.2-9.8						
9.8-13.1			0.01			
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 225° - 235°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.11					
3.3-4.9	0.06					
4.9-6.6		0.04				
6.6-8.2		0.04				
8.2-9.8		0.02				
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.19					
3.3-4.9	0.07					
4.9-6.6	0.01	0.05				
6.6-8.2		0.04				
8.2-9.8		0.02				
9.8-13.1			0.01			
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence
of
Open-Ocean Deep Water
Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 245° - 255°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.14					
3.3-4.9	0.11					
4.9-6.6	0.02	0.07				
6.6-8.2		0.04				
8.2-9.8		0.02				
9.8-13.1			0.02			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.21					
3.3-4.9	0.18					
4.9-6.6	0.01	0.06				
6.6-8.2		0.03				
8.2-9.8		0.02				
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 265^{o} - 275^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.36					
3.3-4.9	0.23					
4.9-6.6	0.01	0.07				
6.6-8.2		0.07				
8.2-9.8		0.04				
9.8-13.1			0.01			
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 275^{o} - 285^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.59					
3.3-4.9	0.47					
4.9-6.6	0.05	0.25				
6.6-8.2		0.13				
8.2-9.8		0.04				
9.8-13.1			0.07			
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 285^{o} - 295^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	1.08					
3.3-4.9	1.00					
4.9-6.6	0.12	0.60				
6.6-8.2		0.42				
8.2-9.8		0.24	0.02			
9.8-13.1			0.12			
13.1-16.4			0.02	0.01		
16.4-19.7						
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 295^{o} - 305^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	1.58					
3.3-4.9	2.30					
4.9-6.6	0.32	1.61				
6.6-8.2		1.31				
8.2-9.8		0.60	0.01			
9.8-13.1			0.30			
13.1-16.4			0.10	0.01		
16.4-19.7				0.01		
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 305° - 315°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	2.63					
3.3-4.9	4.03					
4.9-6.6	0.53	2.85				
6.6-8.2		2.33				
8.2-9.8		1.19	0.01			
9.8-13.1			0.72			
13.1-16.4			0.11	0.01		
16.4-19.7				0.01		
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence
of
Open-Ocean Deep Water
Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 315° - 325°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	2.64					
3.3-4.9	4.08					
4.9-6.6	0.50	2.94				
6.6-8.2		2.10				
8.2-9.8		1.17	0.02			
9.8-13.1			0.74			
13.1-16.4			0.06	0.01		
16.4-19.7						
19.7-23.0				0.01		
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 325^{o} - 335^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	2.66					
3.3-4.9	3.29					
4.9-6.6	0.40	2.10				
6.6-8.2		1.50				
8.2-9.8		0.77	0.03			
9.8-13.1			0.42			
13.1-16.4			0.07			
16.4-19.7				0.01		
19.7-23.0						
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 335^{o} - 345^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	2.10					
3.3-4.9	2.13					
4.9-6.6	0.23	0.92				
6.6-8.2		0.64				
8.2-9.8		0.22				
9.8-13.1			0.14			
13.1-16.4			0.02	0.01		
16.4-19.7				0.01		
19.7-23.0				0.01		
23.0+						

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 115° - 125°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01			0.01		
1.6-3.3		0.01					
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 125° - 135°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6			0.01				
1.6-3.3		0.01					
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 135^{o} - 145^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6				0.01			
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 145^{o} - 155^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3		0.01					
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 155^{o} - 165^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3			0.01				
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 165^{o} - 175^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3		0.02	0.01				
3.3-4.9		0.01					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3				0.01			
3.3-4.9		0.01					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 185° - 195°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.02					
1.6-3.3	0.01	0.02	0.01		0.01		
3.3-4.9		0.01	0.01				
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 195° - 205°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6			0.01				
1.6-3.3		0.09	0.01				
3.3-4.9		0.02					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.01					
1.6-3.3	0.02	0.03					
3.3-4.9		0.01					
4.9-6.6			0.01				
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01	0.01				
1.6-3.3		0.03	0.01				
3.3-4.9		0.01					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 225° - 235°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.03					
1.6-3.3	0.01	0.07	0.02		0.01		
3.3-4.9		0.02	0.01				
4.9-6.6		0.01	0.01	0.01			
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.02					
1.6-3.3	0.01	0.09	0.01				
3.3-4.9		0.04	0.01				
4.9-6.6		0.01					
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 245° - 255°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01		0.01				
1.6-3.3	0.01	0.07			0.01		
3.3-4.9		0.07			0.01	0.01	0.02
4.9-6.6			0.01	0.01			0.04
6.6-8.2				0.01			0.03
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.03	0.01	0.01			
1.6-3.3	0.02	0.03	0.02	0.03	0.01		0.01
3.3-4.9		0.03		0.01	0.01		0.01
4.9-6.6			0.01				0.16
6.6-8.2							0.02
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

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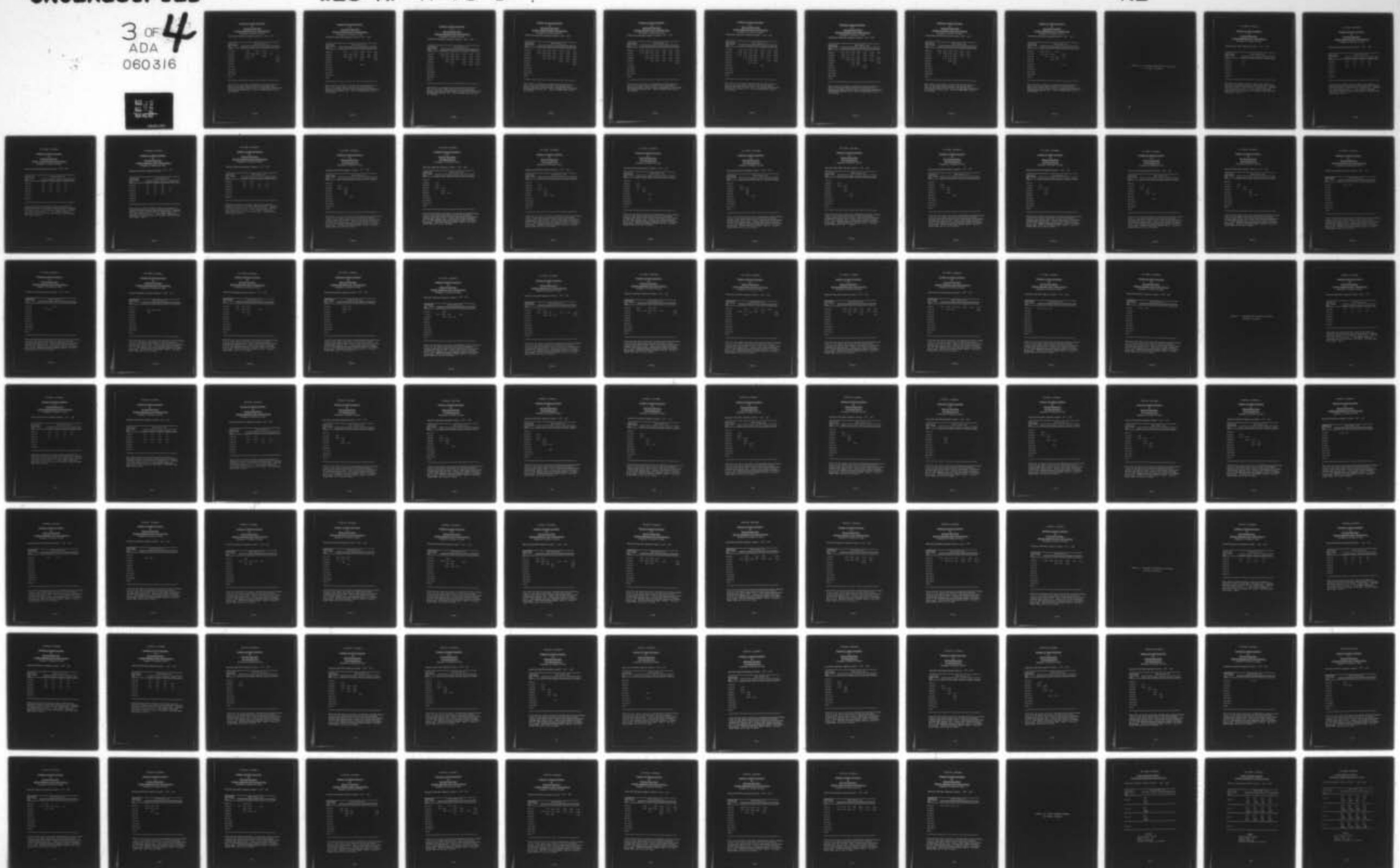

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 265^{o} - 275^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.04		0.01	0.04		
1.6-3.3		0.07	0.05	0.01	0.06	0.02	
3.3-4.9		0.02	0.04		0.02		0.01
4.9-6.6		0.01					0.02
6.6-8.2							0.01
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.02		0.05	0.05	0.02	0.01
1.6-3.3		0.07	0.06	0.03	0.18	0.02	0.02
3.3-4.9		0.03	0.02	0.02	0.08	0.09	0.02
4.9-6.6			0.02		0.01		0.03
6.6-8.2							
8.2-9.8					0.01		
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 285^{o} - 295^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.04	0.05	0.03	0.05	0.16	0.06	0.01
1.6-3.3	0.02	0.22	0.04	0.10	0.73	0.21	0.01
3.3-4.9		0.10	0.02	0.05	0.18	0.33	0.07
4.9-6.6		0.01	0.02		0.01	0.09	0.02
6.6-8.2			0.01		0.01	0.01	0.03
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 295^{o} - 305^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.21	0.12	0.04	0.44	0.16	0.01
1.6-3.3	0.10	0.99	0.07	0.32	2.14	0.63	0.07
3.3-4.9		0.23	0.07	0.11	0.45	0.93	0.26
4.9-6.6		0.01	0.01	0.01	0.03	0.11	0.15
6.6-8.2					0.02	0.01	0.01
8.2-9.8							0.01
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 305^{o} - 315^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.09	0.50	0.37	0.05	0.95	0.21	0.01
1.6-3.3	0.36	2.98	0.21	0.39	3.60	0.98	0.15
3.3-4.9		1.31	0.21	0.10	0.74	2.11	0.42
4.9-6.6		0.03	0.10	0.03	0.04	0.13	0.21
6.6-8.2			0.02	0.02	0.01	0.03	0.10
8.2-9.8							0.02
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 315^{o} - 325^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.11	0.61	0.75	0.09	0.80	0.28	0.02
1.6-3.3	0.46	3.62	0.25	0.37	1.45	0.45	0.03
3.3-4.9	0.01	2.61	0.46	0.13	0.54	0.41	0.09
4.9-6.6		0.10	0.38	0.05	0.07	0.17	0.10
6.6-8.2			0.08	0.03		0.02	0.03
8.2-9.8			0.01	0.02			
9.8-13.1					0.01		
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 325^{o} - 335^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.15	0.51	0.54	0.06	0.25	0.06	0.02
1.6-3.3	0.44	3.28	0.27	0.13	0.49	0.09	
3.3-4.9	0.03	2.70	0.41	0.07	0.18	0.15	0.01
4.9-6.6		0.07	0.42	0.04	0.03	0.04	0.01
6.6-8.2			0.06	0.05			0.02
8.2-9.8			0.01	0.02	0.01		
9.8-13.1					0.01		
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = 335^{o} - 345^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.05	0.42	0.16	0.02	0.03	0.01	
1.6-3.3	0.28	2.48	0.28	0.08	0.05	0.02	
3.3-4.9		1.39	0.53	0.04	0.01	0.01	
4.9-6.6		0.02	0.13	0.07			
6.6-8.2			0.03	0.03			
8.2-9.8				0.03			
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

Frequency of Annual Occurrence

of

Open-Ocean Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Unsheltered Deep Water Approach Azimuth = $345^{\circ} - 355^{\circ}$

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.03	0.10		0.01			
1.6-3.3	0.04	0.50	0.05		0.01		
3.3-4.9		0.15	0.10	0.01	0.01		
4.9-6.6			0.01	0.01			
6.6-8.2							
8.2-9.8					0.01		
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are a mid-point interpolation between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International Incorporated, February 1977. The wave height bands are 0.5 or 1.0 meter.

APPENDIX VIII: SHELTERED DEEP WATER WAVE STATISTICS,
LAS FLORES, CALIFORNIA

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LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.6				
1.0-1.9	1.2				
2.0-2.9	0.2				
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 185° - 195°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	2.9	6.3	3.6	0.2	
1.0-1.9	5.0	4.8	1.8	0.6	
2.0-2.9	0.5	0.3	0.2	0.1	
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	2.7	1.3	0.3	0.5	
1.0-1.9	4.8	3.6	0.6	0.1	
2.0-2.9	0.8	1.3	0.4	0.1	
3.0-3.9	0.1	0.4	0.4	0.1	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

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Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.7	0.1	0.1		
1.0-1.9	2.9	1.3	0.1	0.1	
2.0-2.9	2.1	2.1	0.5	0.1	
3.0-3.9	0.4	0.7	0.4		
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215° - 225°

Significant Wave Height, feet	Wave Period, sec. 12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.7	0.4			
1.0-1.9	2.8	3.0	0.2	0.1	
2.0-2.9	2.4	1.5	0.4	0.1	
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

LAS FLORES. CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.11					
3.3-4.9	0.08	0.02				
4.9-6.6		0.03				
6.6-8.2		0.02				
8.2-9.8			0.01			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $185^{\circ} - 195^{\circ}$

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.17					
3.3-4.9	0.06					
4.9-6.6	0.01	0.05				
6.6-8.2		0.04				
8.2-9.8		0.01	0.02			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES. CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.17					
3.3-4.9	0.11					
4.9-6.6	0.02	0.10				
6.6-8.2		0.06				
8.2-9.8		0.01	0.02			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.10					
3.3-4.9	0.06					
4.9-6.6	0.01	0.05				
6.6-8.2		0.03				
8.2-9.8			0.01			
9.8-13.1						
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215° - 225°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.11					
3.3-4.9	0.06	0.03				
4.9-6.6		0.04				
6.6-8.2		0.02				
8.2-9.8			0.01			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 225^{o} - 235^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.19					
3.3-4.9	0.08	0.05				
4.9-6.6		0.04				
6.6-8.2		0.02				
8.2-9.8			0.01			
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 245^{o} - 255^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.14					
3.3-4.9	0.13	0.07				
4.9-6.6		0.04				
6.6-8.2		0.02				
8.2-9.8			0.02			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $255^{\circ} - 265^{\circ}$

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.21					
3.3-4.9	0.19	0.06				
4.9-6.6		0.03				
6.6-8.2		0.02				
8.2-9.8						
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth ≈ 265° - 275°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.59					
3.3-4.9	0.01	0.07				
4.9-6.6		0.07				
6.6-8.2		0.04	0.01			
8.2-9.8						
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	3.15					
3.3-4.9	0.17	1.39				
4.9-6.6		0.28	0.02			
6.6-8.2			0.19			
8.2-9.8			0.02	0.01		
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 165° - 175°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01	0.01				
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $175^{\circ} - 185^{\circ}$

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6				0.01			
1.6-3.3		0.01	0.01				
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 185° - 195°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3		0.02	0.01	0.01			
3.3-4.9		0.01					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 195° - 205°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.02	0.01				
1.6-3.3	0.02	0.14	0.02		0.01		
3.3-4.9		0.04	0.01				
4.9-6.6			0.01				
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01	0.01				
1.6-3.3		0.03	0.01				
3.3-4.9		0.01					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.03					
1.6-3.3	0.01	0.07	0.02		0.01		
3.3-4.9		0.03	0.02	0.01			
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 225^{o} - 235^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.02					
1.6-3.3	0.01	0.09	0.01		0.01	0.01	0.02
3.3-4.9		0.04	0.01	0.01			0.07
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 235° - 245°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01		0.02	0.01			
1.6-3.3	0.01	0.14	0.02	0.03	0.02		0.02
3.3-4.9			0.01				0.18
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 245^{o} - 255^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.07		0.01	0.10	0.02	
1.6-3.3	0.02	0.15	0.09	0.01	0.02		0.03
3.3-4.9		0.01					0.01
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.09	0.33	0.60	3.71	1.10	0.12
1.6-3.3		0.03	0.17	0.19	0.78	1.56	0.61
3.3-4.9			0.01		0.01		0.01
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 265^{o} - 275^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.17	6.26	0.79	0.59	5.33	3.47	0.89
1.6-3.3		0.37	0.12				0.02
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	1.02	6.93	1.91				
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

LAS FLORES, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 285° - 295°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.62	6.57					
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

APPENDIX IX: SHELTERED DEEP WATER WAVE STATISTICS, *OCEANSIDE, CALIFORNIA*

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $185^{\circ} - 195^{\circ}$

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.6	4.2	2.7	0.3	
1.0-1.9	1.4	1.3	0.6	0.1	
2.0-2.9					
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.8	4.2	1.9	0.7	
1.0-1.9	3.4	2.3	0.7	0.1	
2.0-2.9	0.1	0.1	0.1		
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	3.0	1.1	0.1	0.3	
1.0-1.9	7.2	4.6	0.6	0.1	
2.0-2.9	2.9	3.3	0.9	0.2	
3.0-3.9	0.5	1.1	0.8	0.2	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

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OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.7	0.4			
1.0-1.9	2.8	3.0	0.2	0.1	
2.0-2.9	2.4	1.5	0.4	0.1	
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

OCEANSIDE. CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 185^{o} - 195^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.10					
3.3-4.9	0.01	0.01				
4.9-6.6		0.02				
6.6-8.2		0.02	0.01			
8.2-9.8						
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.17					
3.3-4.9	0.06	0.05				
4.9-6.6	0.01	0.04				
6.6-8.2		0.01				
8.2-9.8			0.02			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence
of
Sheltered Deep Water
Sea Characteristics
(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.27					
3.3-4.9	0.17					
4.9-6.6	0.03	0.15				
6.6-8.2		0.09				
8.2-9.8		0.01	0.03			
9.8-13.1						
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence
of
Sheltered Deep Water
Sea Characteristics
(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215° - 225°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.11					
3.3-4.9	0.06					
4.9-6.6		0.03				
6.6-8.2		0.04				
8.2-9.8		0.02	0.01			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $225^\circ - 235^\circ$

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.19					
3.3-4.9	0.07					
4.9-6.6	0.01	0.05				
6.6-8.2		0.04				
8.2-9.8		0.02	0.01			
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.14					
3.3-4.9	0.13	0.07				
4.9-6.6		0.04				
6.6-8.2		0.02				
8.2-9.8			0.02			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 245° - 255°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3						
3.3-4.9		0.06				
4.9-6.6		0.03				
6.6-8.2		0.02				
8.2-9.8						
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.80					
3.3-4.9	0.20	0.07				
4.9-6.6		0.07				
6.6-8.2		0.04	0.01			
8.2-9.8						
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 265° - 275°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	1.06					
3.3-4.9	0.05	0.25				
4.9-6.6		0.13				
6.6-8.2		0.04	0.07			
8.2-9.8			0.01			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

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OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	5.96					
3.3-4.9	0.44	3.93				
4.9-6.6		0.84	0.33			
6.6-8.2			0.22	0.02		
8.2-9.8			0.02	0.01		
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 165^{o} - 175^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01	0.01				
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 175° - 185°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01		0.01			
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE. CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $185^{\circ} - 195^{\circ}$

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3		0.02	0.01				
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $195^{\circ} - 205^{\circ}$

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.02					
1.6-3.3	0.01	0.02	0.01	0.01	0.01		
3.3-4.9		0.02	0.01				
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.01	0.01				
1.6-3.3	0.02	0.15	0.02				
3.3-4.9		0.05					
4.9-6.6			0.01				
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.03					
1.6-3.3	0.01	0.07	0.02		0.01		
3.3-4.9		0.02	0.01				
4.9-6.6		0.01	0.01	0.01			
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 225° - 235°

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.02					
1.6-3.3	0.01	0.09	0.01		0.01	0.01	0.02
3.3-4.9		0.05	0.01	0.01			0.04
4.9-6.6				0.01			0.03
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

<u>Frequency of Annual Occurrence</u>

<u>of</u>

<u>Sheltered Deep Water</u>

<u>Northern Hemisphere Swell Characteristics</u>

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.03	0.02	0.01			
1.6-3.3	0.01	0.13	0.02	0.03	0.02		0.05
3.3-4.9		0.07	0.01				0.19
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.3-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 245° - 255°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.04		0.01	0.04		0.03
1.6-3.3	0.02	0.09	0.09	0.01	0.08	0.02	0.05
3.3-4.9		0.01					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.02	0.07	0.08	0.23	0.04	
1.6-3.3		0.10	0.05	0.02	0.09	0.09	
3.3-4.9					0.01		
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 265° - 275°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.61	4.95	1.17	1.07	8.76	5.29	1.32
1.6-3.3		1.68	0.13	0.32	0.74	0.71	0.25
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

OCEANSIDE, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.58	6.93	1.91	0.66	3.48	1.31	0.27
1.6-3.3			0.01	0.02	0.01		
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

APPENDIX X: SHELTERED DEEP WATER WAVE STATISTICS, ENCINITAS, CALIFORNIA

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $185^{\circ} - 195^{\circ}$

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.6	4.2	2.7	0.3	
1.0-1.9	1.4	1.3	0.6	0.1	
2.0-2.9					
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $195^{\circ} - 205^{\circ}$

Significant Wave Height, feet	Wave Period, sec. 12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.8	4.3	1.9	0.6	
1.0-1.9	3.4	2.3	0.7	0.1	
2.0-2.9	0.1	0.1	0.1		
3.0-3.9					
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	2.3	1.0	0.1	0.3	
1.0-1.9	4.3	3.3	0.5	0.1	
2.0-2.9	0.8	1.2	0.4	0.1	
3.0-3.9	0.1	0.4	0.4	0.1	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Southern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	1.4	0.5	0.1		
1.0-1.9	5.7	4.3	0.3	0.1	
2.0-2.9	4.1	3.4	0.7	0.1	
3.0-3.9	0.8	0.9	0.6	0.1	
4.0-4.9					
5.0-5.9					
6.0-6.9					

These data are based on Station A data in the report "A Statistical Survey of Ocean Wave Characteristics in Southern California Waters", Marine Advisors, January 1961. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 185^{o} - 195^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.10					
3.3-4.9	0.03					
4.9-6.6						
6.6-8.2						
8.2-9.8						
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.07					
3.3-4.9	0.03	0.01	0.03			
4.9-6.6	0.01	0.02	0.02			
6.6-8.2		0.01	0.02			
8.2-9.8				0.01		
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.17					
3.3-4.9	0.11					
4.9-6.6	0.02	0.10				
6.6-8.2		0.06				
8.2-9.8		0.01	0.01			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.22					
3.3-4.9	0.12					
4.9-6.6	0.01	0.08				
6.6-8.2		0.07				
8.2-9.8		0.02	0.02			
9.8-13.1						
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 225° - 235°

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3						
3.3-4.9						
4.9-6.6						
6.6-8.2						
8.2-9.8			0.01			
9.8-13.1						
13.1-16.4			0.01			
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.33					
3.3-4.9	0.19					
4.9-6.6	0.02	0.12				
6.6-8.2		0.08				
8.2-9.8		0.03	0.02			
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 255° - 265°

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.21					
3.3-4.9	0.18					
4.9-6.6	0.01	0.06				
6.6-8.2		0.03				
8.2-9.8		0.02				
9.8-13.1						
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 265^{o} - 275^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	0.36					
3.3-4.9	0.25	0.07				
4.9-6.6		0.07				
6.6-8.2		0.04	0.07			
8.2-9.8			0.01			
9.8-13.1			0.01			
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 275^{o} - 285^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	2.68					
3.3-4.9	0.64	0.84				
4.9-6.6		0.54				
6.6-8.2		0.28	0.14			
8.2-9.8						
9.8-13.1			0.02	0.01		
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Sea Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 285^{o} - 295^{o}

Significant Wave Height, feet	Wave Period, sec.					
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9
0.0-1.6						
1.6-3.3	7.21					
3.3-4.9	0.58	5.50				
4.9-6.6		1.20	0.01			
6.6-8.2			0.66			
8.2-9.8			0.15	0.01		
9.8-13.1				0.02		
13.1-16.4						
16.4-19.7						
19.7-23.0						
23.0+						

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6				0.01			
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth ≈ 185° - 195°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01					
1.6-3.3		0.02	0.01				
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01					
1.6-3.3	0.01	0.02	0.01	0.01	0.01		
3.3-4.9		0.01	0.01				
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.01	0.01				
1.6-3.3	0.02	0.12	0.01				
3.3-4.9		0.03					
4.9-6.6			0.01				
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.03	0.01				
1.6-3.3	0.01	0.10	0.03		0.01		
3.3-4.9		0.03	0.01				
4.9-6.6		0.01	0.01	0.01			
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 225^{o} - 235^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01	0.02					
1.6-3.3	0.01	0.09	0.01				0.06
3.3-4.9		0.04	0.01				0.03
4.9-6.6		0.01					
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01		0.01	0.01			
1.6-3.3	0.01	0.07		0.03	0.02		0.02
3.3-4.9		0.07	0.01	0.01	0.01	0.01	0.16
4.9-6.6				0.01			0.02
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = $245^{o} - 255^{o}$

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.07	0.01	0.01	0.04	0.02	0.01
1.6-3.3	0.02	0.13	0.11	0.01	0.08	0.12	0.05
3.3-4.9		0.03	0.01				0.06
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.02		0.05	0.05	0.27	0.02
1.6-3.3		0.10	0.09	0.06	0.26	0.42	0.13
3.3-4.9			0.02		0.01	0.01	
4.9-6.6					0.01		
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS. CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 265° - 275°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.04	0.05	0.03	0.15	0.89		
1.6-3.3	0.02	0.32	0.07	0.05	0.19		
3.3-4.9		0.01	0.02		0.01		
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	1.12	8.91	2.22	1.39	9.91	6.15	1.19
1.6-3.3	0.01	4.29	0.88	0.37	1.38	0.46	0.50
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

ENCINITAS, CALIFORNIA

Frequency of Annual Occurrence

of

Sheltered Deep Water

Northern Hemisphere Swell Characteristics

(Frequency in Percent of Year)

Sheltered Deep Water Approach Azimuth = 285^{o} - 295^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.62	6.57	1.72	0.37			
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							
16.4-19.7							
19.7-23.0							
23.0+							

These data are based on mid-point interpolations between Stations 5 and 6 in the report "Wave Statistics for Six Deep-Water Stations Along the California Coast", Meteorology International, Incorporated, February 1977. Adjusted for island sheltering by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Sheltered Deep Water Depth = 600 ft. The wave height bands are 0.5 and 1.0 meter.

APPENDIX XI: ANNUAL LONGSHORE TRANSPORT, LAS FLORES, CALIFORNIA

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.6 1.0 +2.5 +1175				
1.0-1.9	1.2 2.4 +4.0 +3588				
2.0-2.9	0.2 3.7 +6.0 +2636				
3.0-3.9					

Legend

Time (Percent of Year).
Breaker Height. H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 185° - 195°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	2.9 1.1 +3.0 +926	6.3 1.2 +2.2 +1836	3.6 1.3 +1.4 +816	0.2 1.4 +0.5 +15	
1.0-1.9	5.0 2.5 +4.5 +18609	4.8 2.6 +3.7 +16223	1.8 2.7 +2.9 +5319	0.6 2.8 +2.0 +1377	
2.0-2.9	0.5 3.7 +6.0 +6591	0.3 3.8 +5.0 +3530	0.2 3.9 +4.0 +2264	0.1 4.0 +3.0 +1007	
3.0-3.9					

Legend

Time (Percent of Year).
Breaker Height. H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	2.7 1.1 +4.5 +1290	1.3 1.2 +2.5 +430	0.3 1.3 +1.0 +40	0.5 1.4 0 0	
1.0-1.9	4.8 2.5 +5.5 +21790	3.6 2.6 +4.0 +13148	0.6 2.7 +2.5 +1508	0.1 2.8 +1.5 +83	
2.0-2.9	0.8 3.8 +6.5 +12577	1.3 3.9 +5.0 +16325	0.4 4.0 +4.0 +4289	0.1 4.1 +3.0 +1071	
3.0-3.9	0.1 4.9 +7.0 +3096	0.4 5.0 +6.5 +12110	0.4 5.2 +5.5 +11330	0.1 5.4 +4.0 +2838	

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

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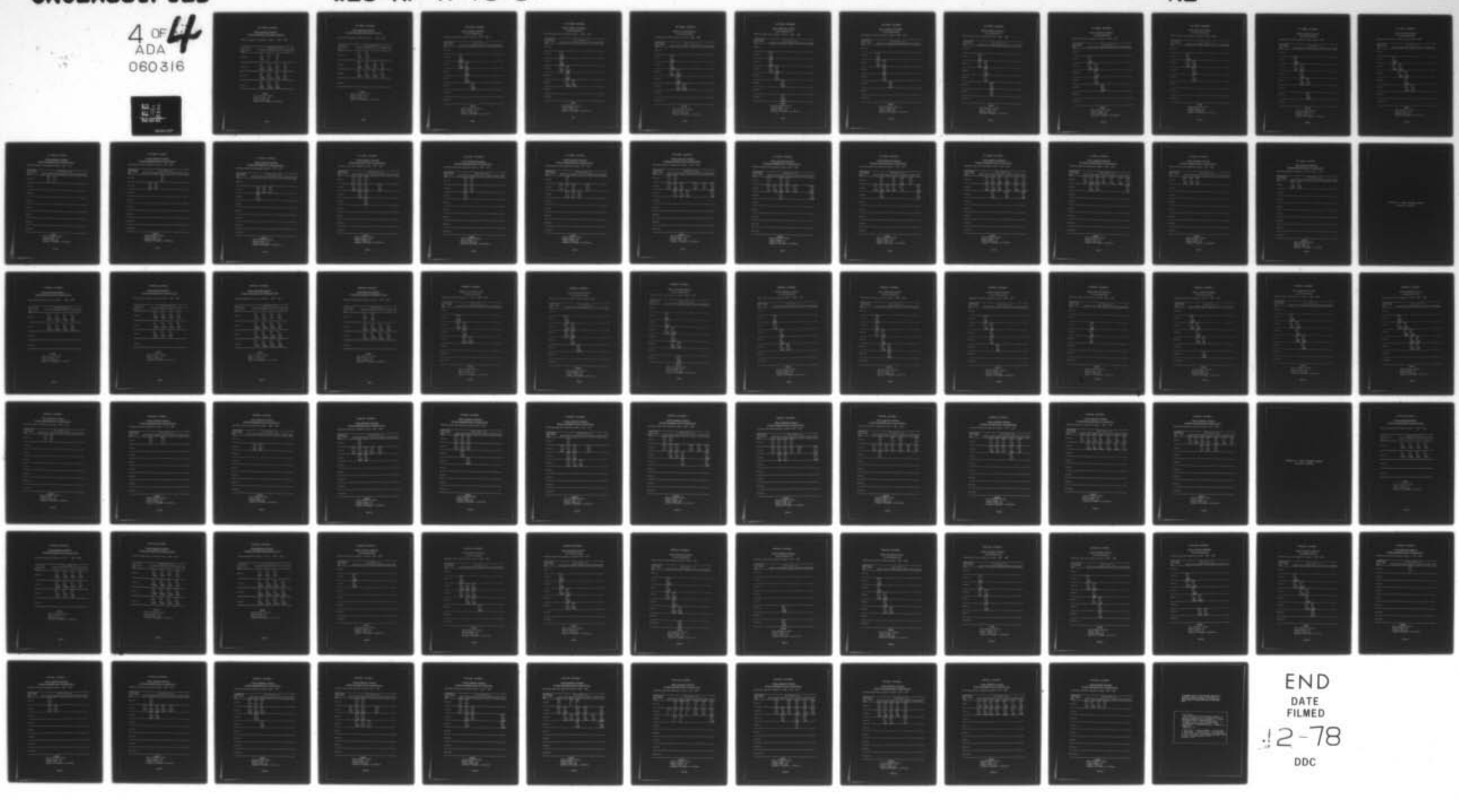

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LAS FLORES, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.7 1.3 +1.5 +170	0.1 1.4 0 0	0.1 1.5 -1.5 -9		
1.0-1.9	2.9 2.6 +2.5 +6633	1.3 2.7 +1.5 +1962	0.1 2.8 +0.5 +55	0.1 2.9 -0.5 -60	
2.0-2.9	2.1 3.9 +3.5 +18507	2.1 4.0 +2.7 +15225	0.5 4.1 +1.8 +2573	0.1 4.2 +1.0 +152	
3.0-3.9	0.4 5.1 +4.5 +8849	0.7 5.3 +3.5 +13282	0.4 5.5 +2.8 +6667		

Legend

Time (Percent of Year).
Breaker Height. H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.7 1.3 -2.5 -283	0.4 1.4 -2.8 -218			
1.0-1.9	2.8 2.6 -1.5 -3846	3.0 2.7 -1.9 -5734	0.2 2.8 -2.3 -507	0.1 2.9 -2.7 -81	
2.0-2.9	2.4 3.9 -1.0 -6057	1.5 4.0 -1.3 -5242	0.4 4.1 -1.7 -1944	0.1 4.2 -2.0 -152	
3.0-3.9					

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.11 2.2 +16.5 +1079						
3.3-4.9	0.08 3.5 +20.0 +2845	0.02 4.0 +14.0 +622					
4.9-6.6		0.03 5.3 +16.0 +2363					
6.6-8.2		0.02 6.6 +17.5 +2656					
8.2-9.8			0.01 8.6 +17.5 +1716				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 185° - 195°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.17 2.5 +13.5 +1795						
3.3-4.9	0.06 3.9 +16.5 +2482						
4.9-6.6	0.01 5.3 +19.0 +549	0.05 5.9 +14.0 +4380					
6.6-8.2		0.04 7.2 +15.5 +6917					
8.2-9.8		0.01 8.5 +17.0 +3249	0.02 9.2 +15.5 +5471				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.17 2.5 +11.0 +1481						
3.3-4.9	0.11 4.0 +13.5 +4008						
4.9-6.6	0.02 5.5 +15.0 +1957	0.10 6.0 +11.0 +8202					
6.6-8.2		0.06 7.4 +12.5 +8684					
8.2-9.8		0.01 8.8 +14.0 +2975	0.02 9.5 +12.5 +6486				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.10 2.7 +7.0 +719						
3.3-4.9	0.06 4.3 +9.0 +1634						
4.9-6.6	0.01 5.8 +11.0 +419	0.05 6.3 +7.5 +2845					
6.6-8.2		0.03 7.8 +8.5 +4111					
8.2-9.8			0.01 9.6 +9.0 +1217				
9.8-13.1							
13.1-16.4			0.01 14.3 +11.5 +4168				

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

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LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 215° - 225°

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16-
0.0-1.6							
1.6-3.3	0.11 2.7 +1.5 +173						
3.3-4.9	0.06 4.3 +3.0 +608	0.03 4.7 +1.5 +207					
4.9-6.6		0.04 6.3 +2.5 +838					
6.6-8.2		0.02 7.8 +3.5 +857					
8.2-9.8			0.01 9.8 +3.5 +505				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 225^{o} - 235^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.19 2.8 -4.0 -831						
3.3-4.9	0.08 4.3 -3.5 -902	0.05 4.9 -3.0 -690					
4.9-6.6		0.04 6.4 -3.0 -1046					
6.6-8.2		0.02 7.9 -3.0 -759					
8.2-9.8			0.01 10.0 -3.0 -456				
9.8-13.1			0.01 12.2 -3.5 -874				
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 245^{o} - 255^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.14 2.7 -11.5 -1549						
3.3-4.9	0.13 4.2 -13.0 -5028	0.07 4.7 -10.5 -2841					
4.9-6.6		0.04 6.2 -11.2 -3522					
6.6-8.2		0.02 7.8 -11.5 -2747					
8.2-9.8			0.02 10.0 -10.0 -5967				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 255° - 265°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.21 2.6 -14.0 -2612						
3.3-4.9	0.19 4.1 -16.0 -8210	0.06 4.6 -13.0 -2744					
4.9-6.6		0.03 6.1 -14.0 -2976					
6.6-8.2		0.02 7.5 -14.5 -4121					
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 265^{o} - 275^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.59 2.6 -18.5 -9320						
3.3-4.9	0.01 4.1 -21.0 -628	0.07 4.4 -17.0 -4072					
4.9-6.6		0.07 5.9 -18.5 -8423					
6.6-8.2		0.04 7.2 -19.5 -8452	0.01 7.5 -16.5 -1157				
8.2-9.8							
9.8-13.1			0.01 10.9 -10.0 -3331				
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 275^{o} - 285^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	3.15 2.3 -20.5 -39857						
3.3-4.9	0.17 3.7 -23.5 -7969	1.39 4.1 -18.0 -66783					
4.9-6.6		0.28 5.4 -19.5 -28822	0.02 5.7 -16.0 -1701				
6.6-8.2			0.19 7.0 -17.5 -33847				
8.2-9.8			0.02 8.3 -18.5 -6590	0.01 8.7 -15.0 -1540			
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 165^{o} - 175^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01 1.0 +7.5 +4	0.01 1.2 +5.5 +4				
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6				0.01 1.4 +3.5 +4			
1.6-3.3		0.01 2.5 +11.5 +53	0.01 2.9 +9.0 +61				
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 185^{o} - 195^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3		0.02 2.8 +9.0 +168	0.01 3.1 +8.0 +64	0.01 3.4 +7.0 +71			
3.3-4.9		0.01 4.3 +11.5 +413					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 195° - 205°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 0.9 +8.0 +3	0.02 1.1 +5.5 +13	0.01 1.3 +5.5 +5				
1.6-3.3	0.02 2.5 +11.0 +204	0.14 2.9 +7.5 +1227	0.02 3.1 +7.0 +169		0.01 3.7 +6.5 +82		
3.3-4.9		0.04 4.5 +9.0 +1465	0.01 4.9 +8.5 +214				
4.9-6.6			0.01 6.5 +10.0 +508				
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 205^o - 215^o

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01 1.2 +1.5 +1	0.01 1.4 +2.0 +2				
1.6-3.3		0.03 3.1 +4.0 +162	0.01 3.3 +4.0 +76				
3.3-4.9		0.01 4.7 +5.7 +261					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.03 3.1 -1.5 -7					
1.6-3.3	0.01 2.7 +1.5 +17	0.07 3.1 0 0	0.02 3.4 -0.5 -15		0.01 3.9 -1.0 -14		
3.3-4.9		0.03 4.7 +1.5 +173	0.02 5.1 +1.0 +84	0.01 5.4 +0.7 +23			
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 225^{o} - 235^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 1.2 -4.5 -7	0.02 1.4 -3.5 -12					
1.6-3.3	0.01 2.8 -4.0 -25	0.09 3.2 -3.0 -423	0.01 3.5 -2.8 -31		0.01 4.1 -2.0 -66	0.01 4.3 -1.7 -31	0.02 4.5 -1.5 -93
3.3-4.9		0.04 4.9 -3.0 -613	0.01 5.2 -2.5 -148	0.01 5.7 -2.3 -172			0.07 6.6 -1.0 -700
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 1.1 -5.5 -3		0.02 1.5 -4.0 -16	0.01 1.7 -3.5 -13			
1.6-3.3	0.01 2.7 -6.5 -74	0.14 3.2 -5.0 -1053	0.02 3.5 -4.5 -198	0.03 3.8 -4.0 -324	0.02 4.2 -3.0 -156		0.02 4.8 -2.0 -146
3.3-4.9			0.01 5.2 -5.0 -295				0.18 7.1 -2.0 -4136
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = $245^{\circ} - 255^{\circ}$

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.07 1.2 -8.0 -72		0.01 1.6 -4.5 -14	0.10 1.8 -4.0 -150	0.02 1.9 -5.0 -36	
1.6-3.3	0.02 2.7 -11.5 -194	0.15 3.1 -9.5 -2052	0.09 3.4 -7.5 -1218	0.01 3.8 -5.5 -148	0.02 4.1 -5.7 -278		0.03 4.6 -6.0 -651
3.3-4.9		0.01 4.7 -10.5 -237					0.01 7.1 -6.0 -770
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.09 1.2 -9.5 -113	0.33 1.4 -8.0 -503	0.60 1.6 -6.5 -1055	3.71 1.7 -6.0 -6992	1.10 1.8 -6.2 -2472	0.12 1.9 -6.4 -319
1.6-3.3		0.03 2.9 -11.5 -386	0.17 3.2 -10.0 -2593	0.19 3.5 -8.0 -2963	0.78 3.8 -7.5 -13767	1.56 4.1 -7.5 -33173	0.61 4.4 -7.5 -15513
3.3-4.9			0.01 5.0 -11.2 -294		0.01 5.8 -8.3 -319		0.01 6.7 -8.0 -442
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 265^{o} - 275^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.17 1.0 -14.5 -194	6.26 1.2 -12.5 -10051	0.79 1.4 -10.5 -1582	0.59 1.5 -8.5 -1145	5.33 1.6 -7.5 -10763	3.47 1.7 -7.5 -8139	0.89 1.8 -7.5 -2421
1.6-3.3		0.37 2.9 -15.0 -6420	0.12 3.1 -12.5 -2071				0.02 3.9 -9.0 -512
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 275^{o} - 285^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	1.02 0.9 -16.5 -536	6.93 1.1 -13.0 -9285	1.91 1.2 -10.5 -2604				
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

LAS FLORES, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 285° - 295°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.62 1.0 -18.5 -897	6.57 1.2 -14.0 -11706					
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

APPENDIX XII: ANNUAL LONGSHORE TRANSPORT, OCEANSIDE, CALIFORNIA

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = $185^\circ - 195^\circ$

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.6 1.3 +6.0 +5401	4.2 1.4 +5.6 +4555	2.7 1.5 +5.3 +3295	0.3 1.6 +5.0 +440	
1.0-1.9	1.4 2.6 +8.0 +10127	1.3 2.7 +7.6 +9830	0.6 2.8 +7.3 +4777	0.1 2.9 +7.0 +1043	
2.0-2.9					
3.0-3.9					

Legend

Time (Percent of Year).
Breaker Height. H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = $195^{\circ} - 205^{\circ}$

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	[illegible]
0.0-0.9	5.8 1.2 +6.0 +4580	4.2 1.3 +5.6 +3784	1.9 1.4 +5.3 +1951	0.7 1.5 +5.0 +749	
1.0-1.9	3.4 2.7 +7.5 +25378	2.3 2.8 +7.1 +17820	0.7 2.9 +6.8 +5878	0.1 3.0 +6.5 +422	
2.0-2.9	0.1 4.0 +8.5 +2816	0.1 4.2 +8.2 +2457	0.1 4.4 +8.0 +674		
3.0-3.9					

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	3.0	1.1	0.1	0.3	
	1.3	1.4	1.5	1.6	
	+2.5	+2.1	+1.8	+1.5	
	+1213	+450	+31	+102	
1.0-1.9	7.2	4.6	0.6	0.1	
	2.7	2.8	3.0	3.2	
	+4.0	+3.6	+3.3	+3.0	
	+28898	+18209	+2588	+576	
2.0-2.9	2.9	3.3	0.9	0.2	
	3.9	4.1	4.3	4.4	
	+5.5	+5.0	+4.5	+4.0	
	+40015	+46958	+12996	+2041	
3.0-3.9	0.5	1.1	0.8	0.2	
	5.2	5.6	6.0	6.4	
	+6.5	+6.0	+5.5	+5.0	
	+16697	+40861	+32407	+6498	

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 215° - 225°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	0.7 1.3 +1.5 +170	0.4 1.4 +2.0 +156			
1.0-1.9	2.8 2.7 +2.5 +7083	3.0 2.9 +2.9 +10453	0.2 3.1 +3.2 +908	0.1 3.3 +3.5 +145	
2.0-2.9	2.4 3.9 +3.5 +21151	1.5 4.2 +3.9 +17718	0.4 4.5 +4.2 +6043	0.1 4.8 +4.5 +475	
3.0-3.9					

Legend

Time (Percent of Year).
Breaker Height. H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 185^{o} - 195^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.10 2.5 +17.5 +1407						
3.3-4.9	0.01 3.8 +21.0 +260	0.01 4.4 +16.5 +610					
4.9-6.6		0.02 5.7 +19.0 +1976					
6.6-8.2		0.02 7.1 +20.5 +3647	0.01 7.6 +18.0 +1291				
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.17 2.4 +14.5 +1730						
3.3-4.9	0.06 3.9 +17.0 +2549	0.05 4.5 +13.5 +2152					
4.9-6.6	0.01 5.4 +19.5 +588	0.04 6.0 +15.5 +4385					
6.6-8.2		0.01 7.5 +17.0 +2376					
8.2-9.8			0.02 9.5 +16.5 +6269				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.27 2.7 +9.5 +2528						
3.3-4.9	0.17 4.2 +12.0 +6085						
4.9-6.6	0.03 5.7 +14.0 +2512	0.15 6.3 +11.0 +13384					
6.6-8.2		0.09 7.8 +12.0 +15253					
8.2-9.8		0.01 9.2 +13.0 +3105	0.03 9.8 +11.5 +8102				
9.8-13.1							
13.1-16.4			0.01 13.8 +12.5 +4124				

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 215^o - 225^o

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.11 2.7 +6.0 +687						
3.3-4.9	0.06 4.2 +7.5 +1420						
4.9-6.6		0.03 6.3 +7.0 +1995					
6.6-8.2		0.04 7.9 +8.0 +4668					
8.2-9.8		0.02 9.4 +8.5 +3278	0.01 10.0 +7.5 +1129				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 225° - 235°

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.19 2.8 +1.5 +313						
3.3-4.9	0.07 4.4 +2.0 +508						
4.9-6.6	0.01 5.9 +2.3 +94	0.05 6.5 +2.2 +1026					
6.6-8.2		0.04 7.9 +2.7 +1594					
8.2-9.8		0.02 9.4 +3.0 +1172	0.01 10.1 +3.2 +498				
9.8-13.1			0.01 12.4 +3.4 +884				
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.14 2.8 -3.2 -484						
3.3-4.9	0.13 4.1 -3.8 -1428	0.07 4.8 -2.7 -786					
4.9-6.6		0.04 6.5 -2.8 -1015					
6.6-8.2		0.02 8.0 -3.0 -783					
8.2-9.8			0.02 10.1 -1.6 -998				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 245° - 255°

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3							
3.3-4.9		0.06 4.7 -6.5 -1486					
4.9-6.6		0.03 6.2 -7.5 -1709					
6.6-8.2		0.02 7.6 -8.0 -2422					
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

421

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 255^o - 265^o

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.80 2.7 -10.5 -16579						
3.3-4.9	0.20 4.1 -13.0 -7203	0.07 4.6 -10.0 -2783					
4.9-6.6		0.07 6.1 -11.5 -5944					
6.6-8.2		0.04 7.5 -13.0 -6520	0.01 8.1 -9.5 -839				
8.2-9.8							
9.8-13.1			0.01 11.8 -11.0 -2471				
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = $265^{o} - 275^{o}$

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	1.06 2.7 -15.0 -15283						
3.3-4.9	0.05 4.1 -18.5 -2543	0.25 4.5 -13.0 -11169					
4.9-6.6		0.13 6.0 -14.5 -12973					
6.6-8.2		0.04 7.5 -16.0 -7882	0.07 8.0 -13.0 -13135				
8.2-9.8			0.01 9.4 -13.5 -1696				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	5.96 2.3 -18.0 -67711						
3.3-4.9	0.44 3.7 -21.5 -18827	3.93 4.1 -16.5 -175414					
4.9-6.6		0.84 5.6 -18.0 -88446	0.33 6.0 -14.0 -32549				
6.6-8.2			0.22 7.6 -16.0 -44228	0.02 8.0 -12.0 -3047			
8.2-9.8			0.02 9.0 -17.5 -5768	0.01 9.4 -13.0 -3276			
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 165^{o} - 175^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01 1.0 +11.5 +5	0.01 1.2 +9.5 +7				
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01 1.0 +11.5 +5		0.01 1.4 +7.0 +8			
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 185^o - 195^o

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3		0.02 2.9 +13.5 +359	0.01 3.2 +12.0 +206				
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 195° - 205°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.02 1.4 +8.5 +28					
1.6-3.3	0.01 2.4 +14.5 +60	0.02 2.9 +11.0 +222	0.01 3.2 +10.0 +86	0.01 3.6 +9.0 +105	0.01 3.9 +8.5 +121		
3.3-4.9		0.02 4.5 +13.5 +807	0.01 4.9 +12.0 +298				
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 1.2 +6.0 +5	0.01 1.4 +5.0 +11	0.01 1.5 +4.0 +11				
1.6-3.3	0.02 2.7 +9.5 +161	0.15 3.1 +7.5 +1571	0.02 3.4 +6.5 +265				
3.3-4.9		0.05 4.7 +9.5 +1720					
4.9-6.6			0.01 6.8 +10.0 +569				
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.03 1.3 +2.5 +12					
1.6-3.3	0.01 2.7 +6.0 +69	0.07 3.1 +5.0 +527	0.02 3.4 +4.0 +123		0.01 3.9 +4.0 +58		
3.3-4.9		0.02 4.7 +6.0 +412	0.01 5.1 +5.5 +309				
4.9-6.6		0.01 6.3 +7.0 +665	0.01 6.9 +6.5 +388	0.01 7.4 +5.9 +420			
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 225^{o} - 235^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 1.2 +0.6 +1	0.02 1.4 +0.4 +1					
1.6-3.3	0.01 2.8 +1.5 +9	0.09 3.1 +1.2 +156	0.01 3.4 +1.4 +14		0.01 3.8 +1.6 +43	0.01 4.0 +1.8 +28	0.02 4.2 +2.0 +104
3.3-4.9		0.05 4.8 +1.8 +350	0.01 5.2 +2.0 +119	0.01 5.6 +2.2 +79			0.04 6.3 +3.2 +1072
4.9-6.6				0.01 7.5 +2.7 +200			0.03 8.3 +4.0 +2286
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 1.3 -216 -2	0.03 1.4 -1.7 -9	0.02 1.5 -1.0 -4	0.01 1.6 -0.2 -1			
1.6-3.3	0.01 2.8 -3.2 -40	0.13 3.1 -2.5 -468	0.02 3.4 -1.3 -53	0.03 3.7 -0.3 -23	0.02 3.9 +0.2 +9		0.05 4.2 +1.0 +139
3.3-4.9		0.07 4.8 -2.7 -786	0.01 5.2 -1.5 -89				0.19 6.2 +1.3 +2036
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 245^{o} - 255^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.04 1.4 -3.5 -27		0.01 1.7 -1.0 -4	0.04 1.8 -0.8 -12		0.03 1.9 -0.4 -5
1.6-3.3	0.02 2.7 -7.0 -120	0.09 3.1 -5.5 -713	0.09 3.4 -4.0 -655	0.01 3.6 -2.5 -59	0.08 3.8 -1.5 -284	0.02 3.9 -1.0 -43	0.05 4.0 -0.5 -69
3.3-4.9		0.01 4.7 -6.5 -149					
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.02 1.4 -6.0 -27	0.07 1.5 -4.0 -58	0.08 1.6 -2.0 -44	0.23 1.8 -1.5 -129	0.04 1.9 -1.0 -17	
1.6-3.3		0.10 3.0 -8.0 -1008	0.05 3.2 -6.0 -420	0.02 3.5 -4.0 -176	0.09 3.7 -2.5 -475	0.09 4.0 -2.0 -462	
3.3-4.9					0.01 5.8 -3.5 -137		
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = $265^{\circ} - 275^{\circ}$

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.61 1.1 -9.0 -573	4.95 1.2 -7.5 -4866	1.17 1.3 -6.0 -1133	1.07 1.4 -4.5 -931	8.76 1.5 -3.0 -6075	5.29 1.6 -2.0 -2879	1.32 1.7 -1.5 -628
1.6-3.3		1.68 2.9 -10.5 -20813	0.13 3.2 -8.0 -1602	0.32 3.5 -6.0 -3681	0.74 3.7 -4.5 -7387	0.71 4.0 -3.5 -6670	0.25 4.2 -2.5 -1912
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

OCEANSIDE, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.58 1.1 -12.0 -719	6.93 1.2 -10.5 -9435	1.91 1.3 -8.0 -2447	0.66 1.4 -6.0 -765	3.48 1.5 -5.0 -4006	1.31 1.6 -4.5 -1600	0.27 1.7 -4.0 -340
1.6-3.3			0.01 2.9 -11.5 -77	0.02 3.2 -8.5 -222	0.01 3.5 -7.0 -153		
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

APPENDIX XIII: ANNUAL LONGSHORE TRANSPORT, ENCINITAS, CALIFORNIA

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 185^o - 195^o

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.6 1.2 +8.0 +5862	4.2 1.5 +7.7 +7399	2.7 1.8 +7.4 +7218	0.3 2.1 +7.0 +1210	
1.0-1.9	1.4 2.5 +11.0 +12477	1.3 2.8 +10.3 +14446	0.6 3.2 +9.6 +8702	0.1 3.6 +9.0 +2287	
2.0-2.9					
3.0-3.9					

Legend

Time (Percent of Year).
Breaker Height. H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = $195^{\circ} - 205^{\circ}$

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	5.8 1.2 +9.0 +6807	4.3 1.5 +7.5 +7383	1.9 1.7 +6.0 +3584	0.6 1.9 +4.5 +1171	
1.0-1.9	3.4 2.5 +11.0 +30302	2.3 2.9 +9.5 +25819	0.7 3.3 +7.7 +9169	0.1 3.6 +6.0 +615	
2.0-2.9	0.1 3.7 +12.5 +3349	0.1 4.2 +10.5 +3119	0.1 4.7 +8.5 +843		
3.0-3.9					

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	2.3 1.3 +6.5 +2400	1.0 1.5 +5.0 +1152	0.1 1.7 +3.5 +55	0.3 1.8 +2.5 +251	
1.0-1.9	4.3 2.7 +8.5 +36256	3.3 3.0 +7.0 +29961	0.5 3.3 +5.5 +4544	0.1 3.5 +4.0 +192	
2.0-2.9	0.8 3.9 +10.0 +19787	1.2 4.3 +8.5 +32386	0.4 4.7 +6.7 +10688	0.1 5.0 +5.0 +2921	
3.0-3.9	0.1 5.0 +11.5 +5259	0.4 5.5 +9.7 +22692	0.4 6.0 +7.8 +22836	0.1 6.5 +6.0 +6740	

Legend

Time (Percent of Year).
Breaker Height. H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

440

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Southern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.				
	12-13.9	14-15.9	16-17.9	18-19.9	20+
0.0-0.9	1.4 1.3 +3.0 +679	0.5 1.4 +2.5 +243	0.1 1.5 +2.0 +12		
1.0-1.9	5.7 2.7 +5.0 +28544	4.3 3.0 +4.4 +24688	0.3 3.3 +3.7 +1840	0.1 3.5 +3.0 +721	
2.0-2.9	4.1 3.9 +6.5 +66696	3.4 4.3 +5.9 +64180	0.7 4.7 +5.2 +14569	0.1 5.0 +4.5 +5236	
3.0-3.9	0.8 5.1 +8.0 +31183	0.9 5.6 +7.4 +41075	0.6 6.0 +6.7 +29520	0.1 6.4 +6.0 +2593	

Legend

Time (Percent of Year).
Breaker Height. H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 185^{o} - 195^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.10 2.3 +27.5 +1541						
3.3-4.9	0.03 3.6 +31.0 +1797						
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 195° - 205°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.07 2.3 +22.5 +939						
3.3-4.9	0.03 3.8 +26.0 +1530	0.01 4.3 +20.0 +680	0.03 4.6 +18.0 +2208				
4.9-6.6	0.01 5.2 +29.0 +721	0.02 5.7 +22.5 +2270	0.02 6.0 +20.0 +3127				
6.6-8.2		0.01 7.0 +24.5 +1350	0.02 7.5 +22.0 +4428				
8.2-9.8				0.01 9.3 +21.0 +2434			
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 205^{o} - 215^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.17 2.6 +16.5 +2375						
3.3-4.9	0.11 4.1 +20.5 +6160						
4.9-6.6	0.02 5.6 +23.5 +2995	0.10 6.0 +18.0 +12869					
6.6-8.2		0.06 7.4 +20.0 +13207					
8.2-9.8		0.01 8.7 +22.0 +4278	0.01 9.3 +20.0 +4677				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.22 2.6 +13.5 +2594						
3.3-4.9	0.12 4.5 +16.5 +6777						
4.9-6.6	0.01 5.6 +19.5 +644	0.08 6.1 +15.0 +8873					
6.6-8.2		0.07 7.6 +16.5 +15551					
8.2-9.8		0.02 9.0 +18.0 +5910	0.02 9.5 +15.5 +7905				
9.8-13.1							
13.1-16.4			0.01 14.3 +19.0 +6567				

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 225^{o} - 235^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8			0.01 9.8 +10.5 +1486				
9.8-13.1							
13.1-16.4			0.01 14.5 +13.5 +5013				

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.33 2.6 +4.0 +1193						
3.3-4.9	0.19 4.2 +6.5 +3702						
4.9-6.6	0.02 5.7 +8.0 +1180	0.12 6.3 +6.0 +6000					
6.6-8.2		0.08 7.8 +7.0 +7940					
8.2-9.8		0.03 9.1 +7.5 +5351	0.02 9.8 +6.5 +3732				
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 255° - 265°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.21 2.7 -5.5 -1166						
3.3-4.9	0.18 4.3 -5.5 -3229						
4.9-6.6	0.01 5.8 -6.0 -232	0.06 6.3 -4.5 -2150					
6.6-8.2		0.03 7.8 -5.0 -2035					
8.2-9.8		0.02 9.1 -5.0 -2393					
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 265^{o} - 275^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	0.36 2.7 -11.0 -3837						
3.3-4.9	0.25 4.3 -12.0 -9250	0.07 4.7 -9.0 -2654					
4.9-6.6		0.07 6.3 -9.5 -5368					
6.6-8.2		0.04 7.7 -9.5 -5172	0.07 8.2 -7.0 -7710				
8.2-9.8			0.01 9.6 -7.0 -953				
9.8-13.1			0.01 11.9 -7.0 -3260				
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 275^{o} - 285^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	2.68 2.6 -13.0 -30780						
3.3-4.9	0.64 4.1 -14.5 -25493	0.84 4.6 -11.0 -34471					
4.9-6.6		0.54 6.0 -12.0 -46999					
6.6-8.2		0.28 7.5 -12.5 -44002	0.14 7.9 -9.5 -18906				
8.2-9.8							
9.8-13.1			0.02 11.5 -10.0 -6347	0.01 12.2 -6.5 -1613			
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Sea Characteristics

Sheltered Deep Water Approach Azimuth = 285° - 295°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6							
1.6-3.3	7.21 2.5 -15.0 -85738						
3.3-4.9	0.58 4.1 -18.5 -28537	5.50 4.4 -13.5 -244257					
4.9-6.6		1.20 5.9 -15.0 -121876	0.01 6.3 -11.0 -727				
6.6-8.2			0.66 7.7 -12.5 -110772				
8.2-9.8			0.15 9.1 -13.5 -42236	0.01 9.6 -9.0 -3043			
9.8-13.1				0.02 11.8 -10.0 -6769			
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year.

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 175^{o} - 185^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6				0.01 1.1 +11.5 +7			
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).

Breaker Height, H_b.

Breaker Angle, a_b.

Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 185^{o} - 195^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01 1.2 +18.5 +13					
1.6-3.3		0.02 2.7 +22.5 +467	0.01 2.9 +19.0 +243				
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 195^{o} - 205^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.01 1.1 +13.5 +24					
1.6-3.3	0.01 2.3 +22.5 +78	0.02 2.8 +17.0 +405	0.01 3.1 +15.5 +120	0.01 3.4 +14.0 +138	0.01 3.7 +12.5 +154		
3.3-4.9		0.01 4.3 +20.0 +680	0.01 4.6 +18.0 +368				
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 205° - 215°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 1.1 +12.5 +7	0.01 1.3 +9.0 +8	0.01 1.4 +8.5 +9				
1.6-3.3	0.02 2.6 +16.5 +246	0.12 2.9 +12.5 +1753	0.01 3.2 +11.5 +197				
3.3-4.9		0.03 4.5 +15.0 +1778					
4.9-6.6			0.01 6.5 +16.0 +787				
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 215^{o} - 225^{o}

Significant Wave Height, feet	Wave Period, sec. 4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.03 1.3 +7.0 +39	0.01 1.4 +5.5 +6				
1.6-3.3	0.01 2.6 +13.5 +137	0.10 3.0 +10.0 +1324	0.03 3.3 +8.5 +399		0.01 3.9 +6.5 +93		
3.3-4.9		0.03 4.6 +13.0 +1372	0.01 5.0 +11.0 +578				
4.9-6.6		0.01 6.1 +15.0 +1268	0.01 6.6 +13.0 +677	0.01 7.1 +11.0 +694			
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).

Breaker Height, H_b.

Breaker Angle, a_b.

Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 225^{o} - 235^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 1.0 +5.5 +5	0.02 1.1 +3.0 +5					
1.6-3.3	0.01 2.6 +9.0 +46	0.09 3.0 +6.0 +715	0.01 3.3 +4.0 +38				
3.3-4.9		0.04 4.7 +8.0 +1275	0.01 5.1 +6.0 +337				0.06 6.8 +4.0 +2315
4.9-6.6		0.01 6.3 +10.0 +470					0.03 8.9 +5.0 +3396
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 235^{o} - 245^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.01 1.0 +1.5 +1		0.01 1.3 0 0	0.01 1.4 0 0			
1.6-3.3	0.01 2.6 +4.0 +42	0.07 3.1 +3.0 +293		0.03 3.5 +2.0 +132	0.02 4.0 +1.5 +92		0.02 5.0 +2.0 +161
3.3-4.9		0.07 4.7 +5.0 +1376	0.01 5.1 +4.0 +113	0.01 5.6 +3.0 +107	0.01 6.1 +2.5 +110	0.01 6.7 +2.5 +140	0.16 7.3 +2.5 +4847
4.9-6.6				0.01 7.3 +4.0 +276			0.02 9.6 +3.0 +1647
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 245^{o} - 255^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.07 1.2 -1.0 -9	0.01 1.4 -1.0 -1	0.01 1.7 -1.0 -4	0.04 1.9 -0.5 -8	0.02 2.1 +0.5 +6	0.01 2.3 +1.5 +6
1.6-3.3	0.02 2.7 0 0	0.13 3.2 0 0	0.11 3.6 0 0	0.01 4.1 0 0	0.08 4.5 +0.5 +145	0.12 4.9 +1.0 +537	0.05 5.4 +1.5 +440
3.3-4.9		0.03 4.8 0 0	0.01 5.1 0 0				0.06 7.8 +1.5 +1349
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 255^{o} - 265^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6		0.02 1.2 -4.5 -14		0.05 1.6 -3.0 -37	0.05 1.8 -2.5 -47	0.27 2.0 -1.5 -192	0.02 2.1 -0.5 -5
1.6-3.3		0.10 3.1 -4.5 -621	0.09 3.5 -3.5 -578	0.06 3.9 -3.0 -433	0.26 4.2 -2.5 -1999	0.42 4.5 -1.5 -2264	0.13 4.8 -0.5 -279
3.3-4.9			0.02 5.1 -3.5 -395		0.01 6.0 -2.5 -106	0.01 6.6 -1.5 -162	
4.9-6.6					0.01 7.9 -2.5 -211		
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

460

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 265^{o} - 275^{o}

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.04 1.0 -10.5 -35	0.05 1.2 -8.5 -57	0.03 1.4 -5.5 -31	0.15 1.5 -2.5 -89	0.89 1.6 -1.0 -243		
1.6-3.3	0.02 2.7 -11.0 -186	0.32 3.0 -9.0 -3654	0.07 3.3 -6.0 -681	0.05 3.6 -3.0 -319	0.19 3.8 -1.5 -671		
3.3-4.9		0.01 4.7 -9.0 -204	0.02 5.0 -6.0 -641		0.01 5.7 -2.0 -75		
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 275° - 285°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	1.12 1.0 -11.0 -1013	8.91 1.3 -8.5 -12084	2.22 1.4 -5.0 -2155	1.39 1.5 -1.5 -481	9.91 1.6 -0.5 -1349	6.15 1.7 -0.9 -1753	1.19 1.8 -1.4 -609
1.6-3.3	0.01 2.6 -13.0 -66	4.29 2.9 -10.0 -50538	0.88 3.2 -7.0 -9413	0.37 3.5 -3.0 -2115	1.38 3.8 -2.0 -6500	0.46 4.1 -2.5 -3314	0.50 4.4 -3.0 -5153
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

ENCINITAS, CALIFORNIA

Annual Longshore Transport

Northern Hemisphere Swell Characteristics

Sheltered Deep Water Approach Azimuth = 285° - 295°

Significant Wave Height, feet	Wave Period, sec.						
	4-5.9	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16+
0.0-1.6	0.62 1.0 -11.0 -558	6.57 1.1 -9.0 -6199	1.72 1.2 -5.0 -1133	0.37 1.3 -1.0 -60			
1.6-3.3							
3.3-4.9							
4.9-6.6							
6.6-8.2							
8.2-9.8							
9.8-13.1							
13.1-16.4							

Legend

Time (Percent of Year).
Breaker Height, H_b.
Breaker Angle, a_b.
Longshore Transport, cu yds/year

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Hales, Lyndell Z

Coastal processes study of the Oceanside, California, littoral cell / by Lyndell Z. Hales. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.

60, [290] p. : ill. ; 27 cm. (Miscellaneous paper - U. S. Army Engineer Waterways Experiment Station ; H-78-8)

Prepared for U. S. Army Engineer District, Los Angeles, Los Angeles, Calif.

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TA7.W34m no.H-78-8